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Vanderpool et al.

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(54) **APPARATUS FOR ADJUSTING RELATIVE ORIENTATIONS OF COMPONENTS, AND METHODS OF USE AND MANUFACTURE THEREOF**

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B62D 65/02	(2006.01)
B60J 5/04	(2006.01)

(52) **U.S. Cl.**
CPC ***B62D 65/06*** (2013.01); ***B62D 65/026*** (2013.01); *B60J 5/04* (2013.01)

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See application file for complete search history.

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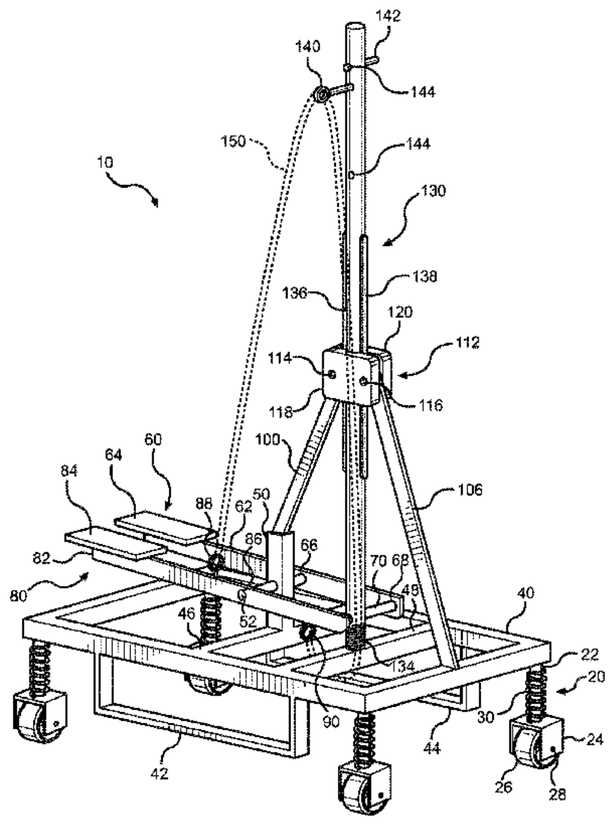
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(74) *Attorney, Agent, or Firm* — Kenealy Vaidya LLP

(57) **ABSTRACT**

Some embodiments are directed to an adjuster for adjusting a position of a vehicle door relative to other vehicle components. The adjuster can include a pin that is configured to be held by a vehicle door latch so as to form a rigid connection between the pin and the vehicle door. The pin can also be configured to be released from the vehicle door latch upon actuation of a vehicle release mechanism. A frame can be supported by a surface that is static relative to the vehicle. An actuator can connect the frame to the pin. The actuator can be configured to enable the vehicle door to be manually raised or lowered by a predetermined distance that facilitates the vehicle door adopting a position that provides enhanced communication between the vehicle door latch and a vehicle striker.

18 Claims, 13 Drawing Sheets



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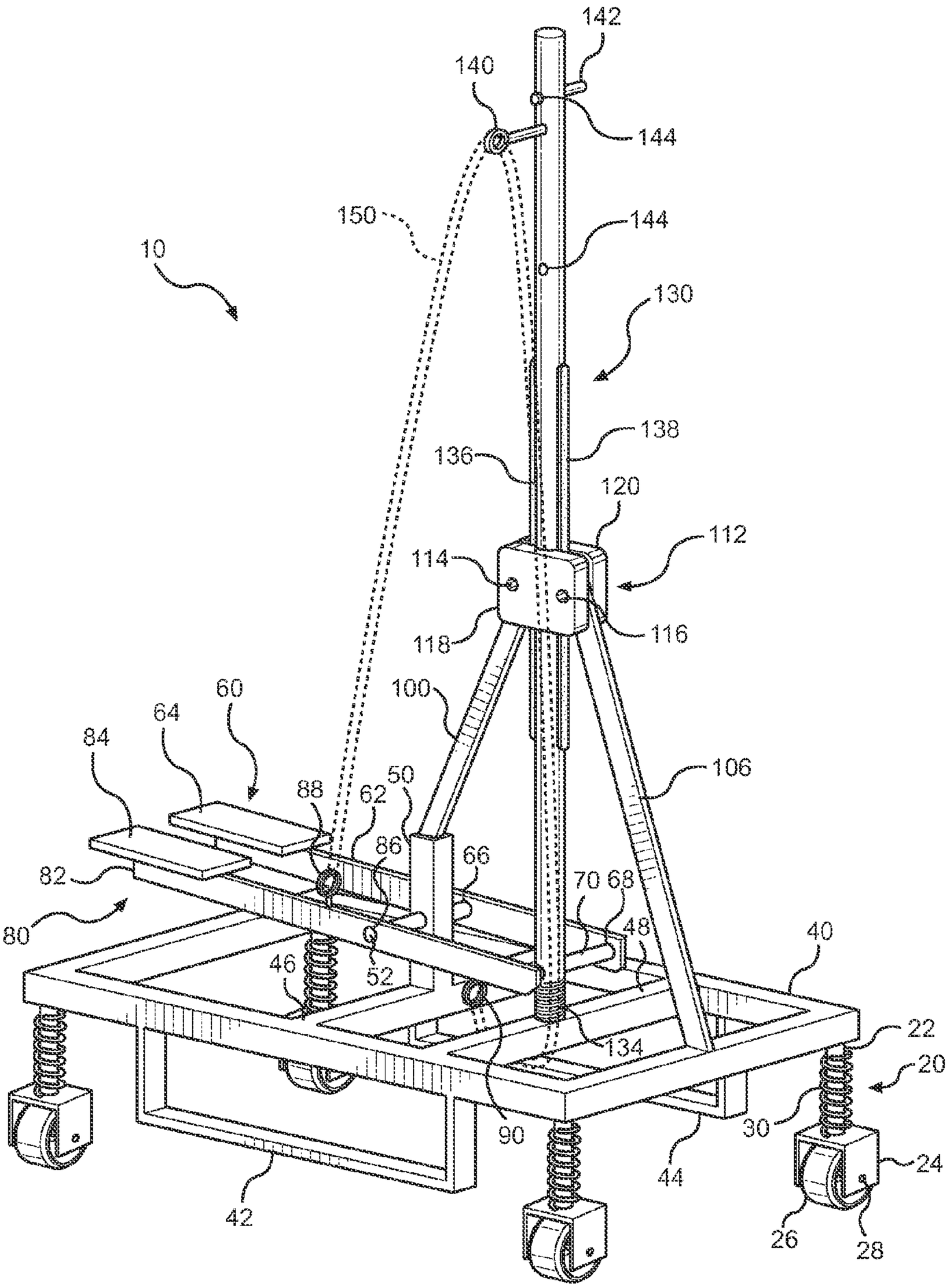

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FIG. 1

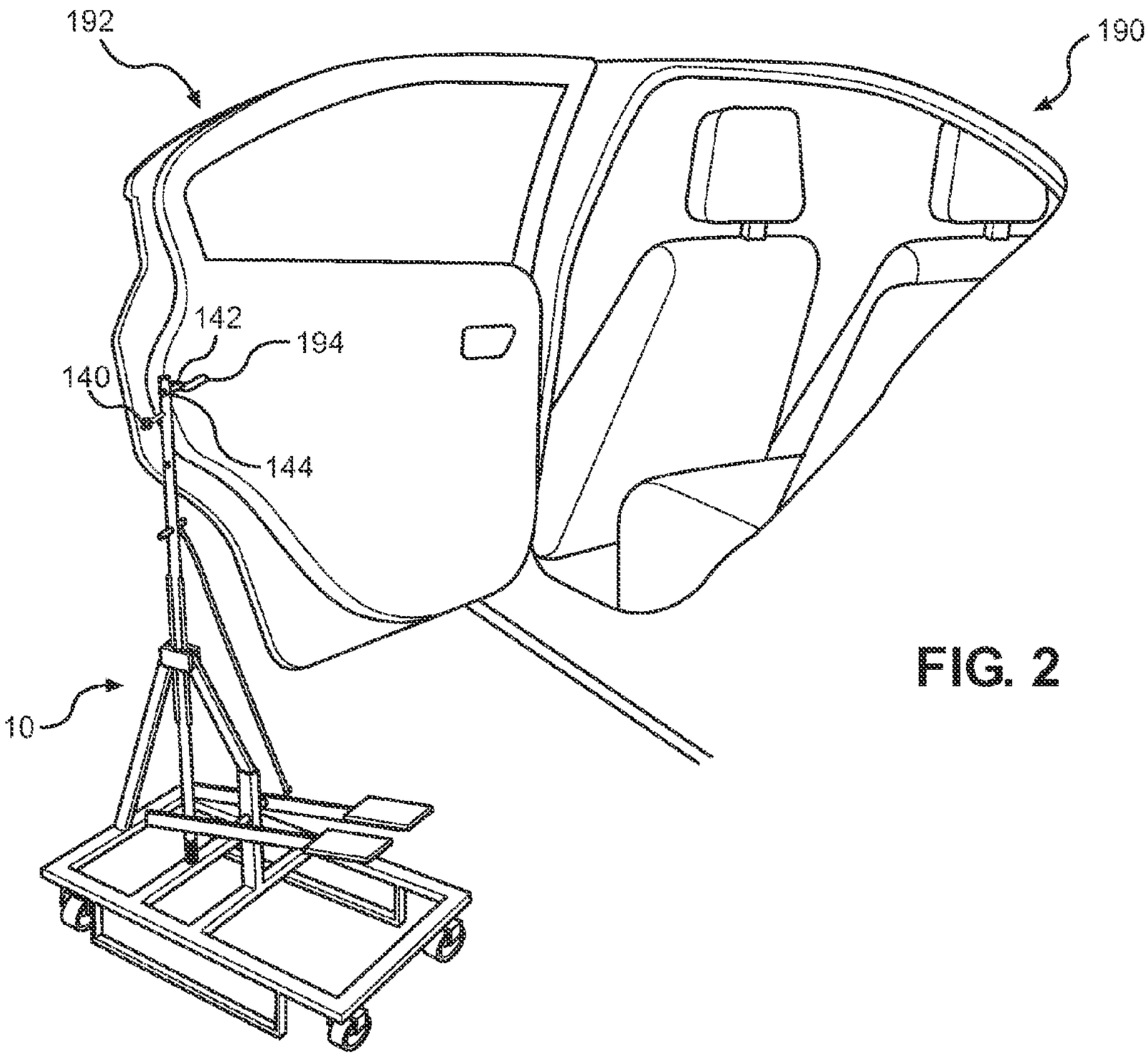


FIG. 2

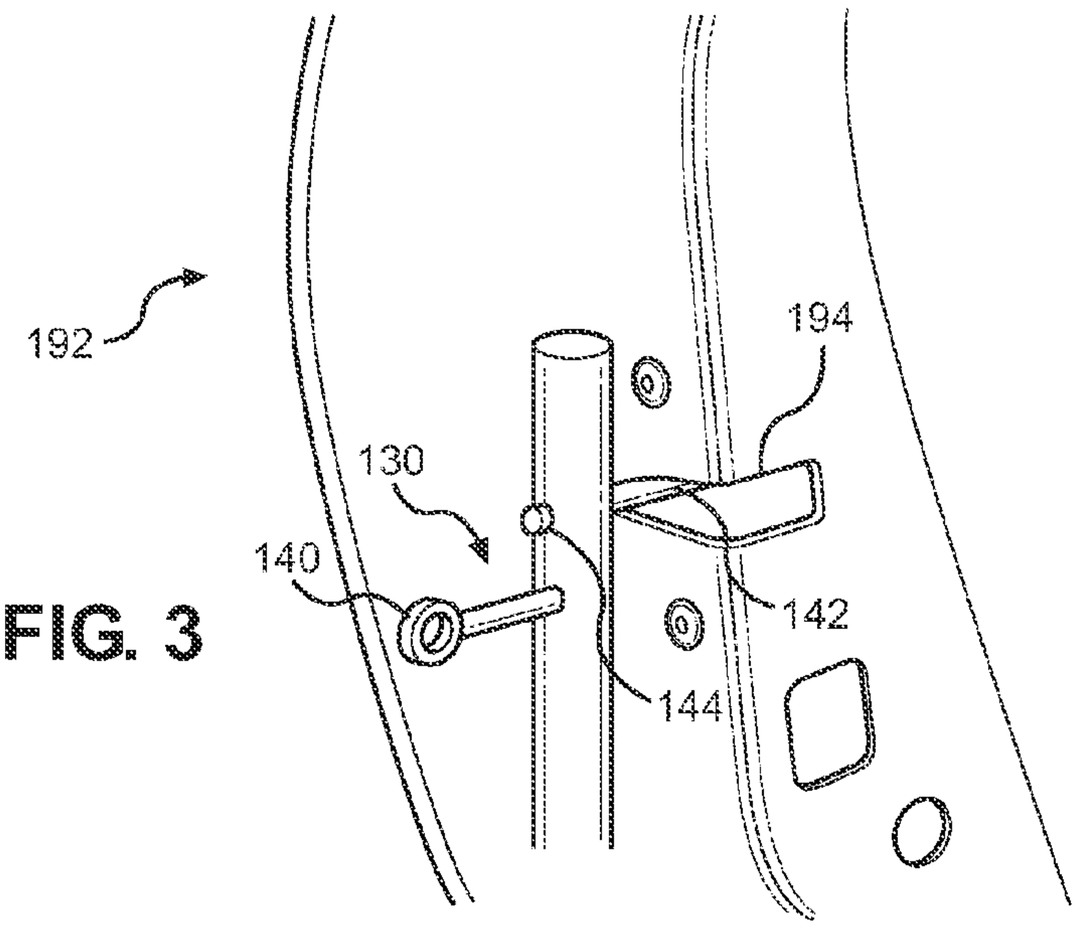


FIG. 3

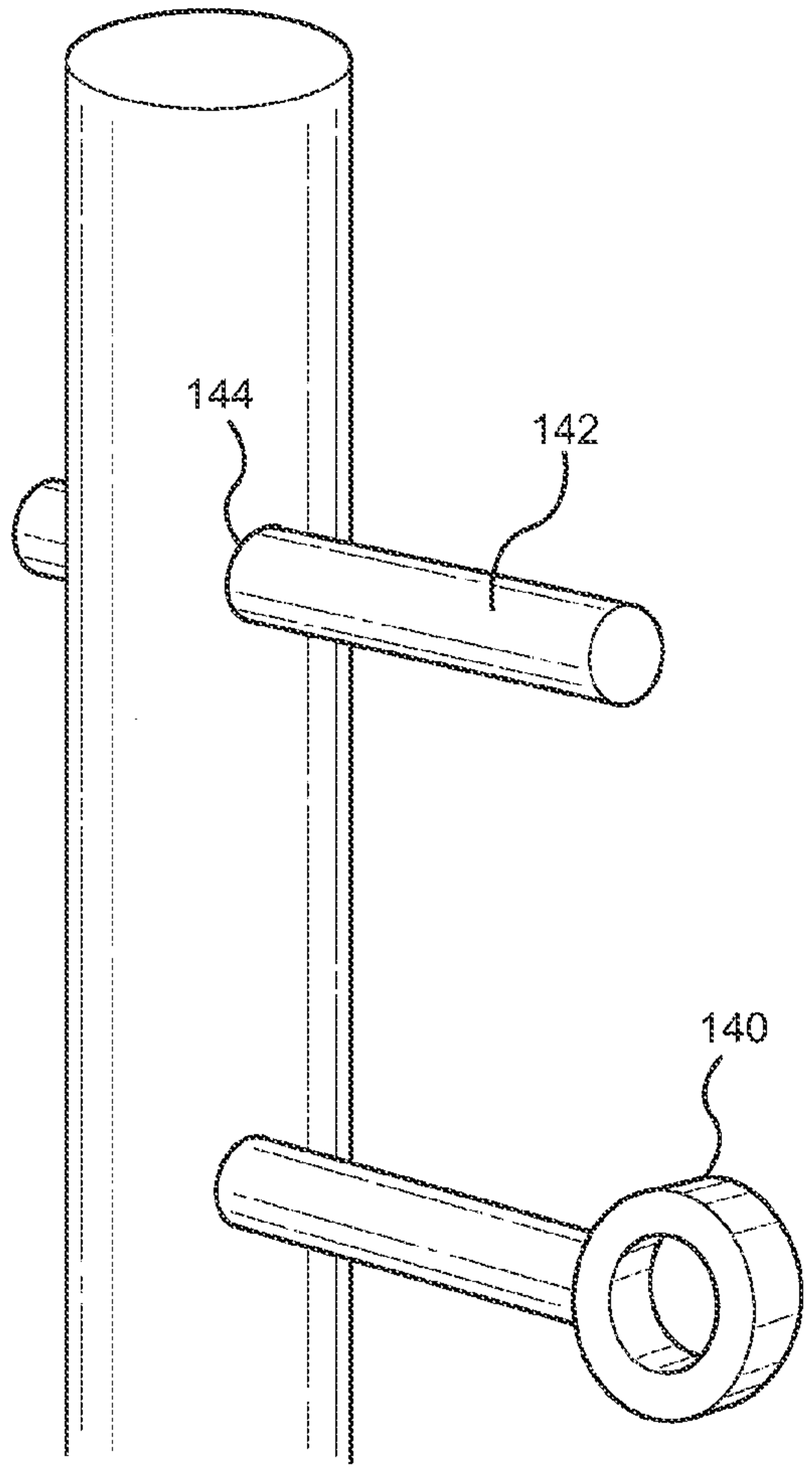


FIG. 4

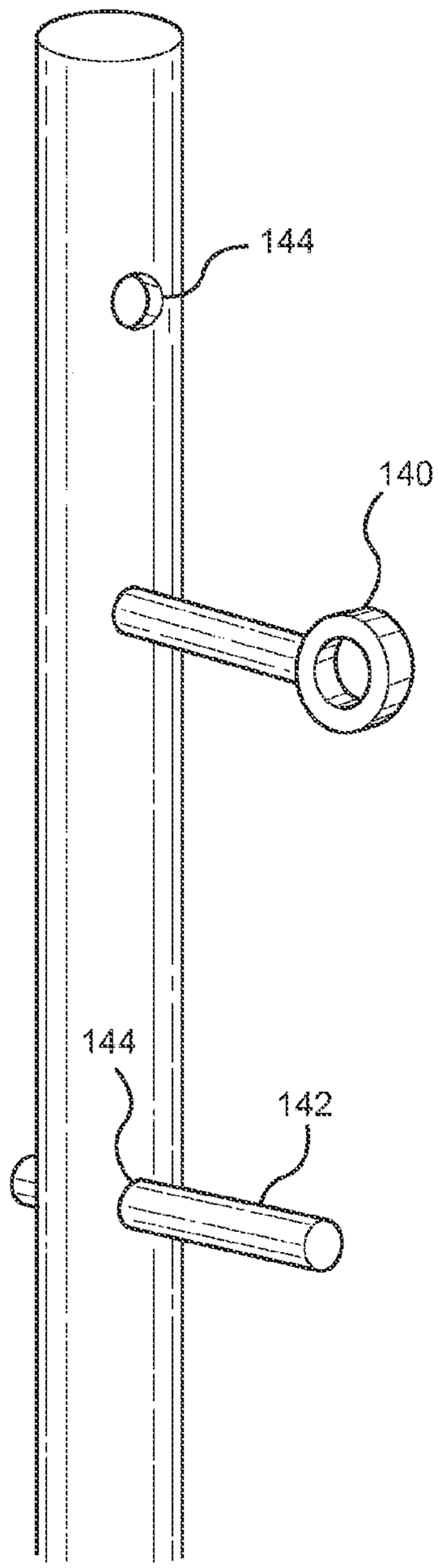


FIG. 5

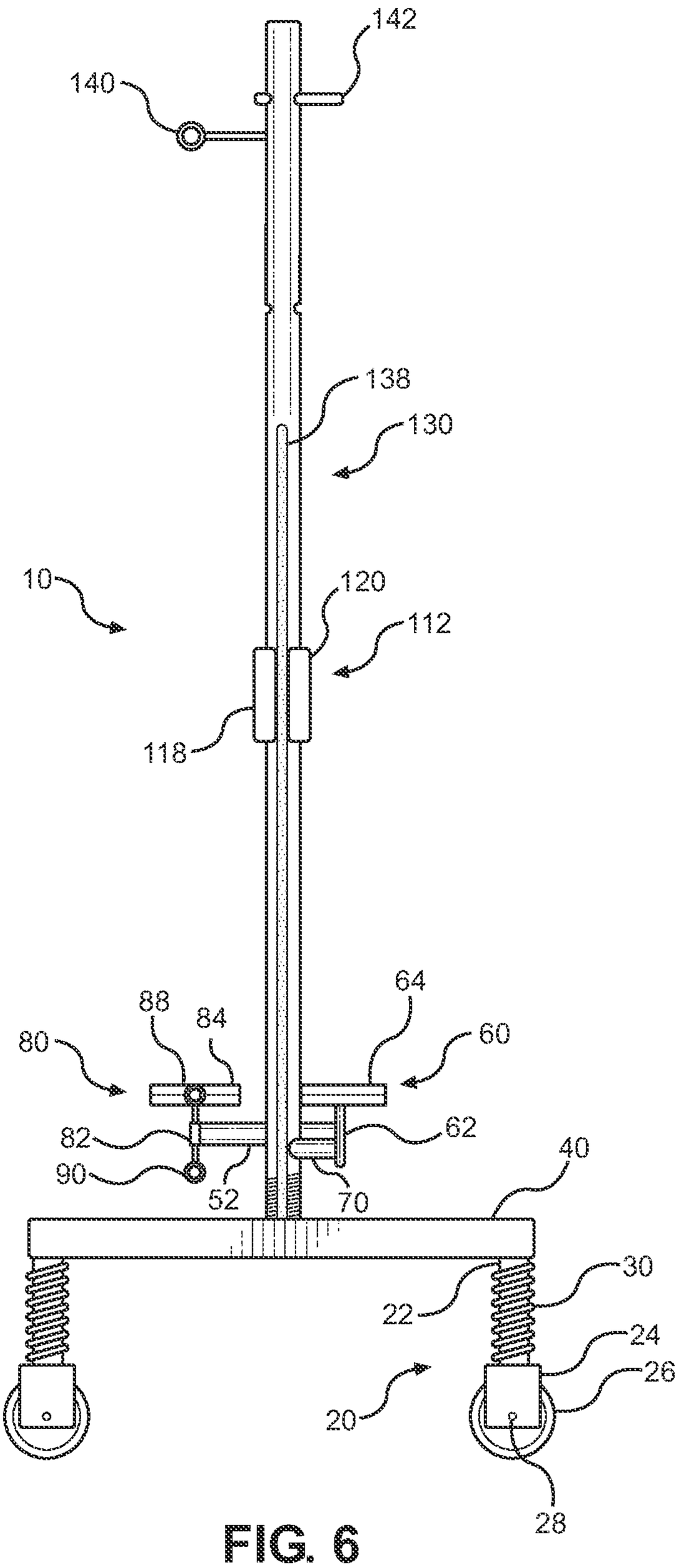

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FIG. 6

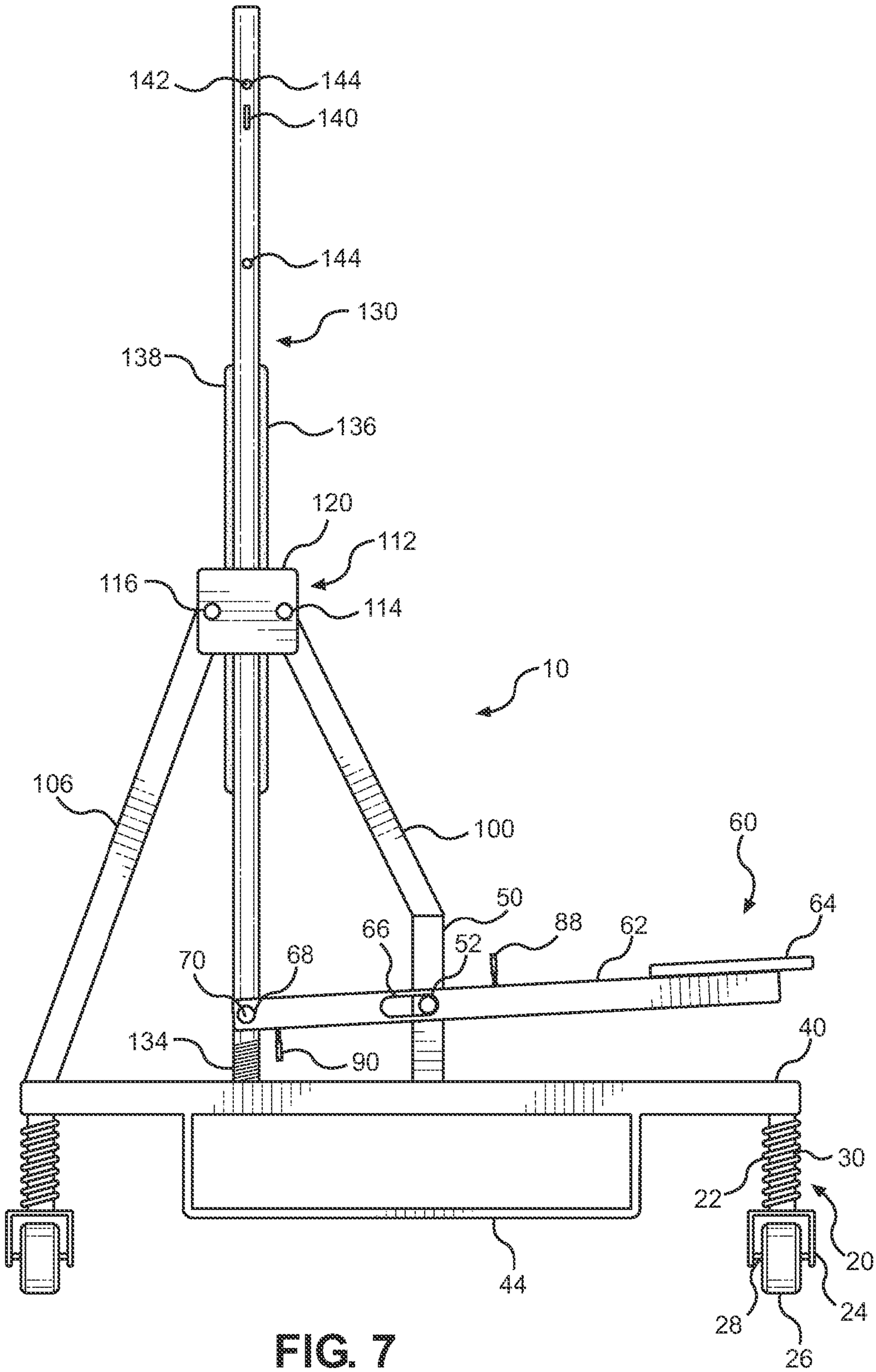

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FIG. 7

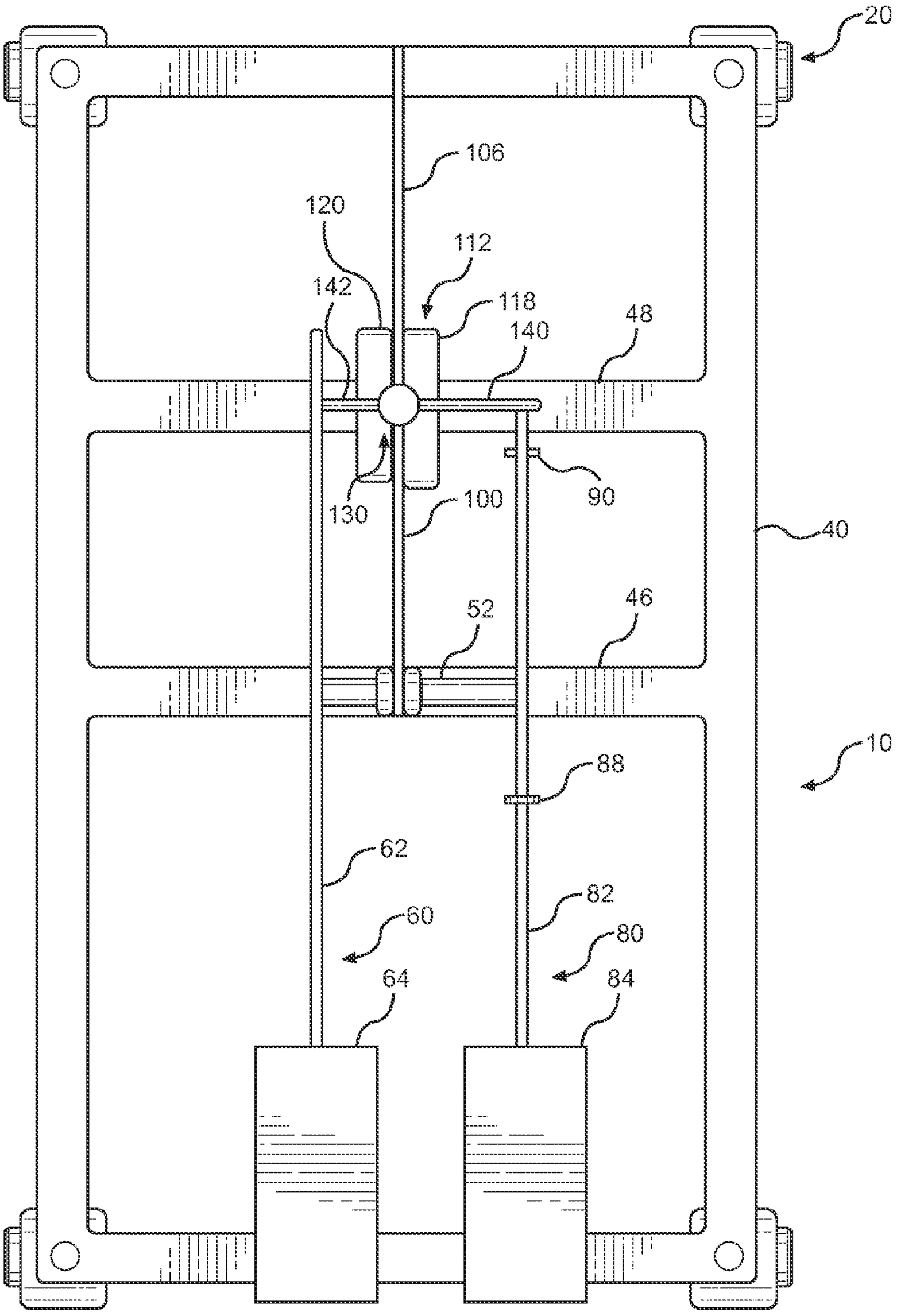

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FIG. 8

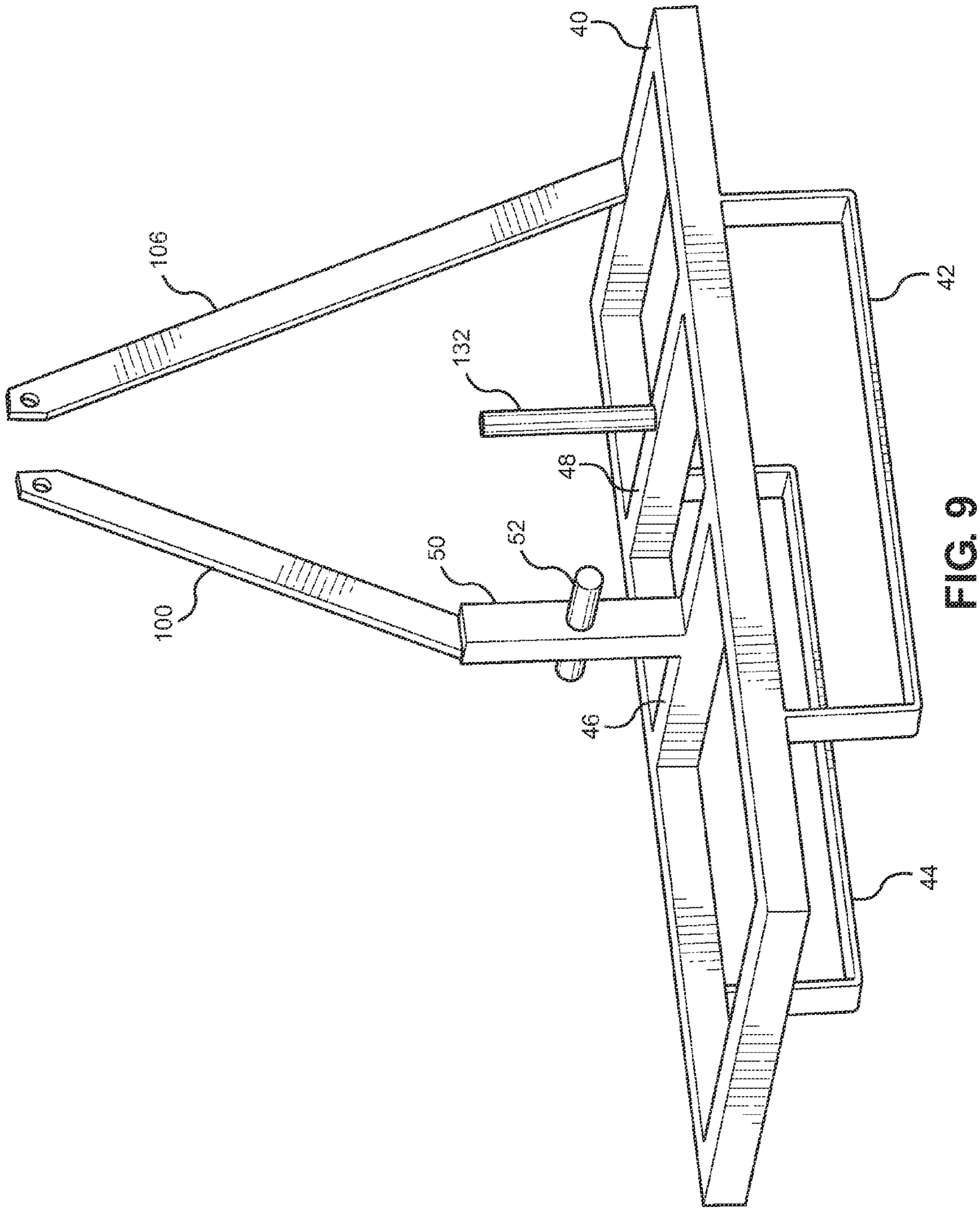


FIG. 9

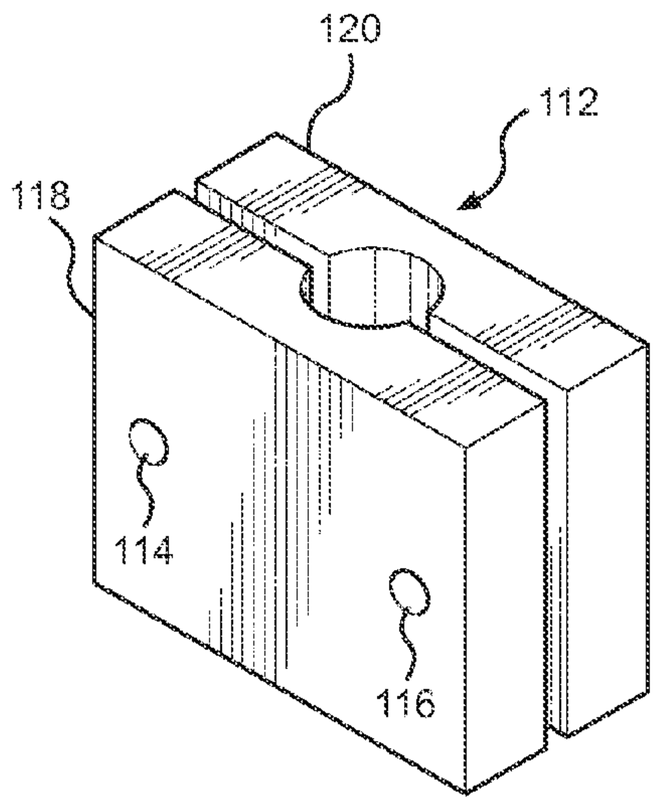


FIG. 10

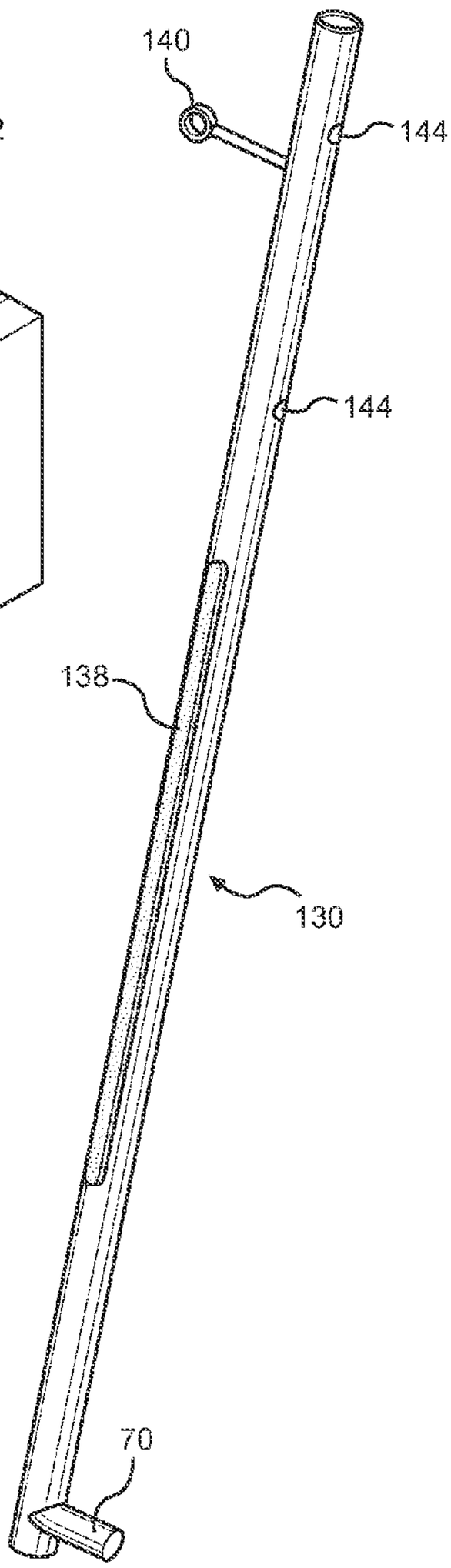


FIG. 11

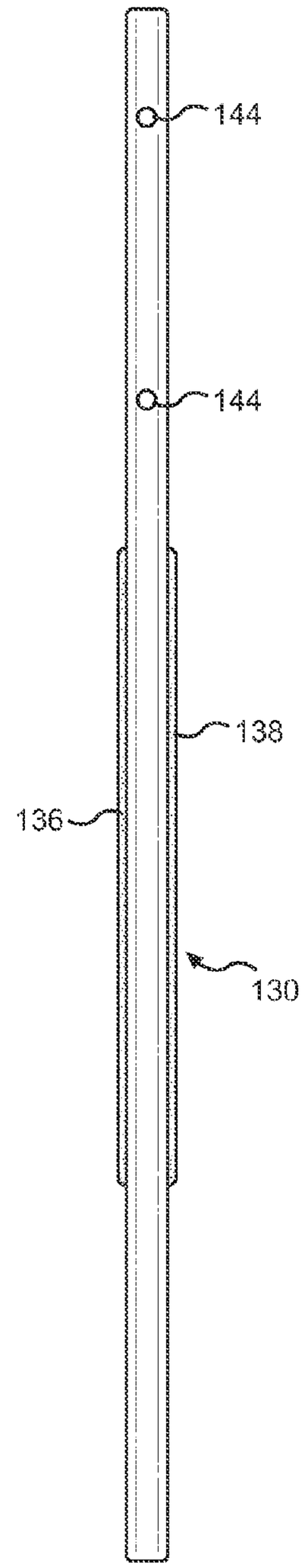


FIG. 12

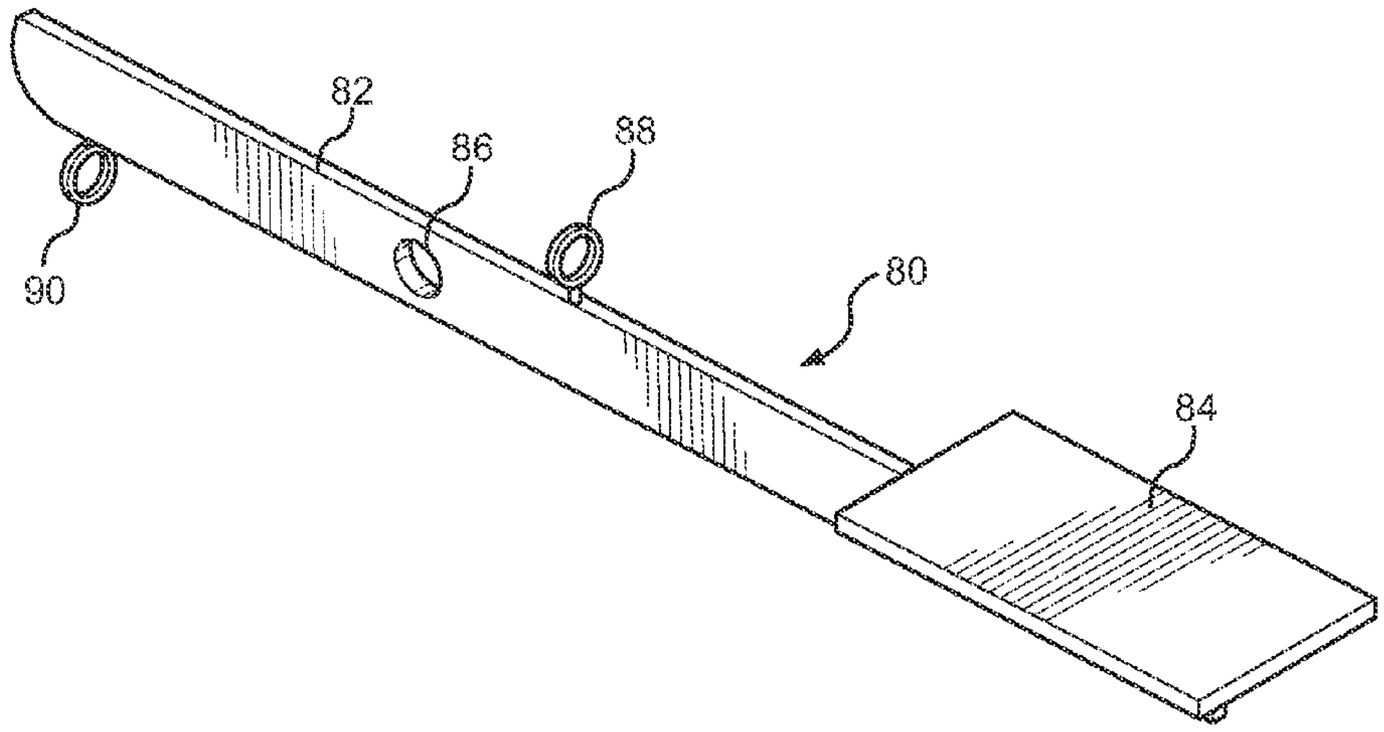


FIG. 13

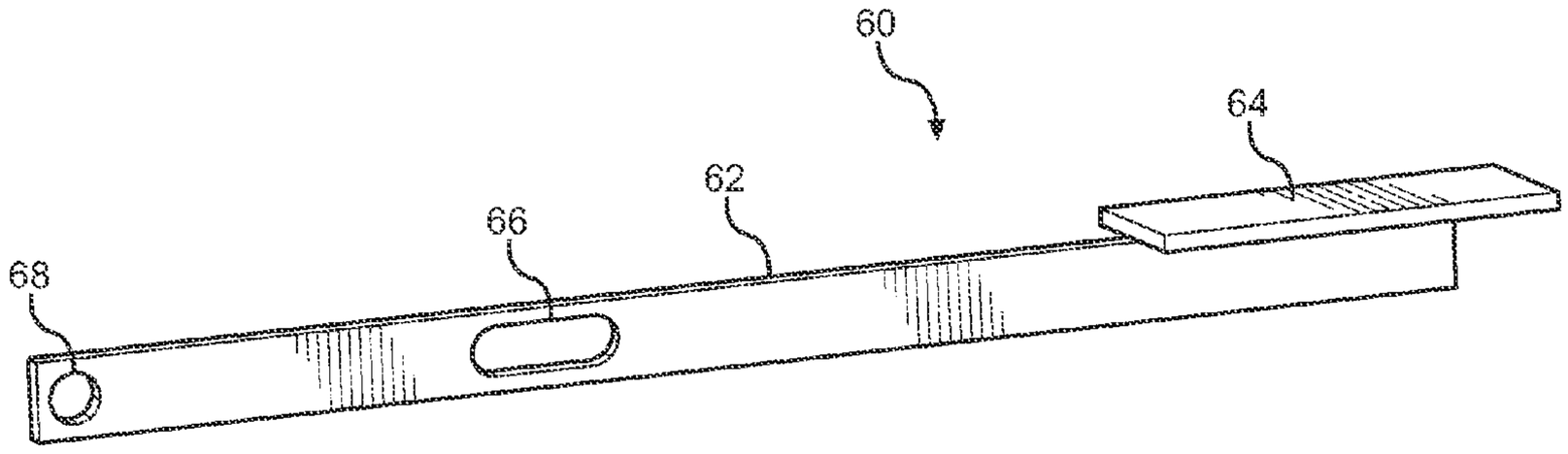


FIG. 14

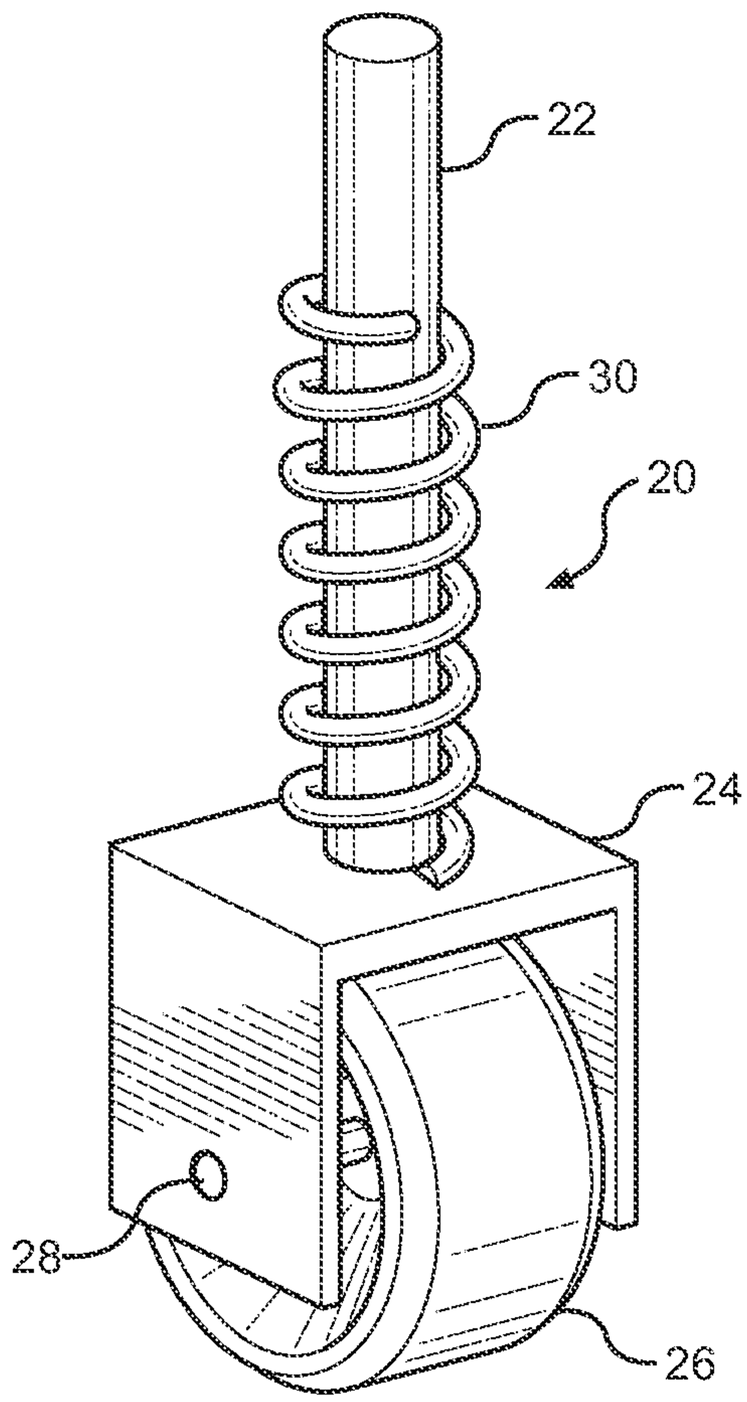


FIG. 15

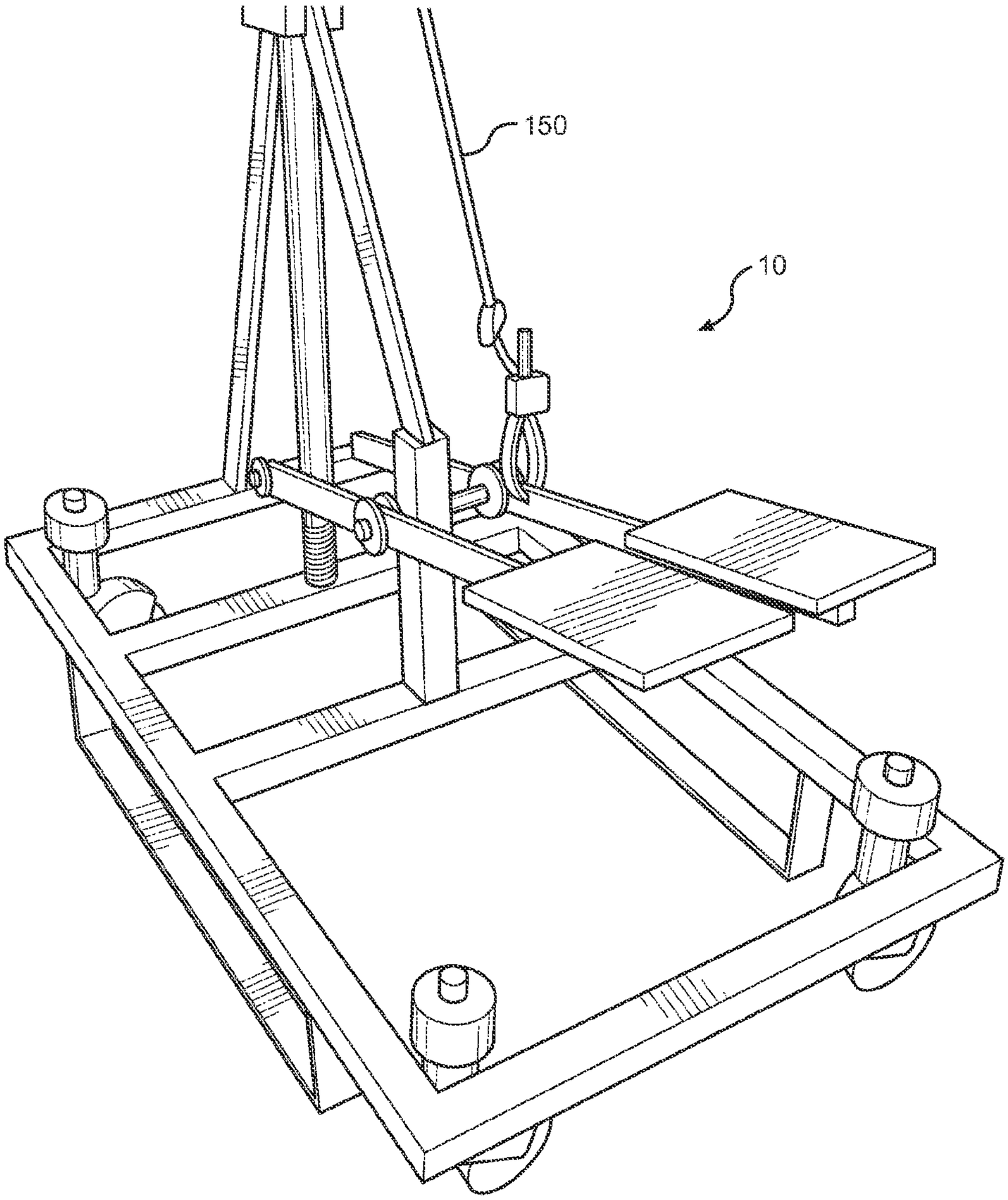


FIG. 16

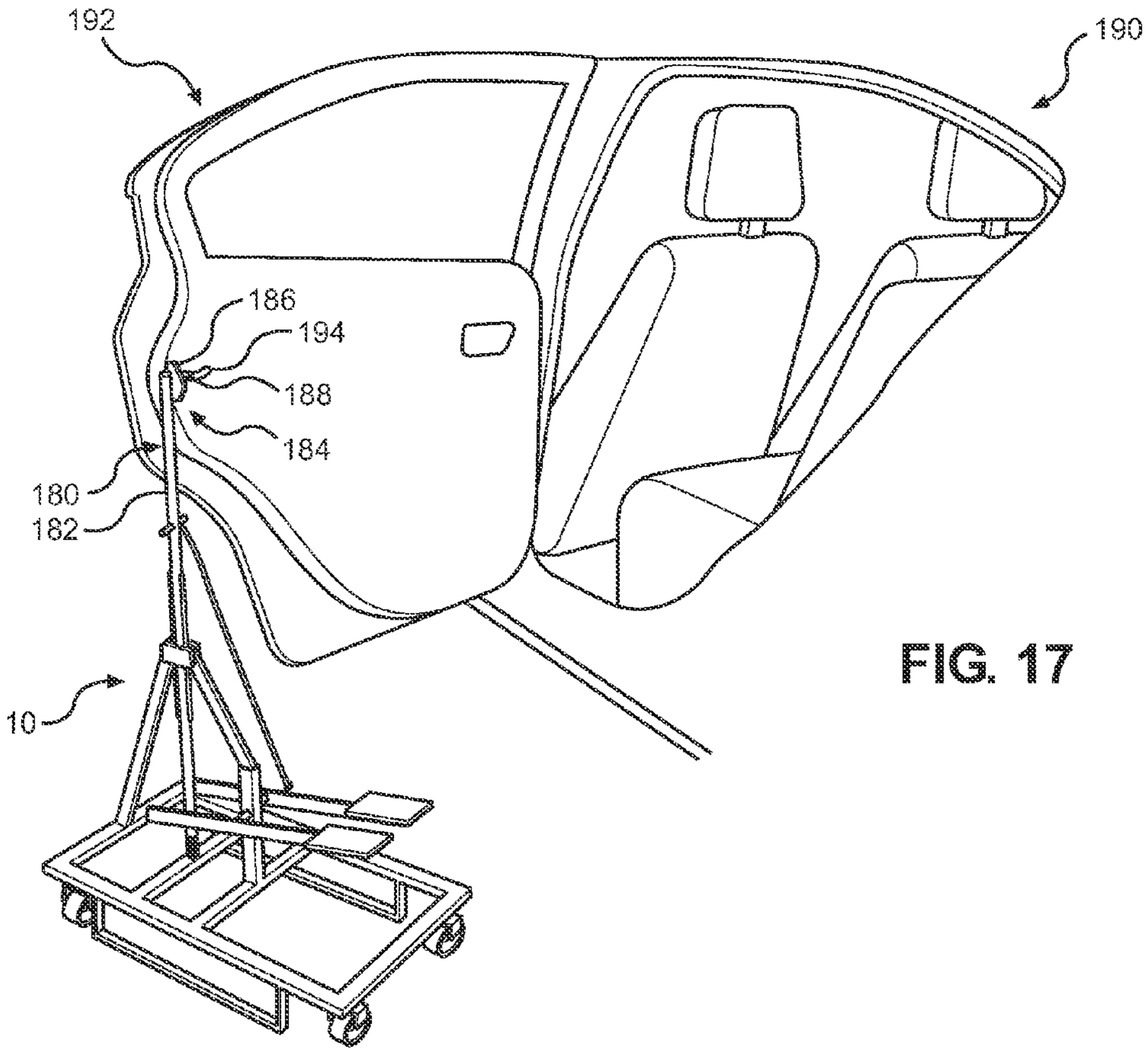


FIG. 17

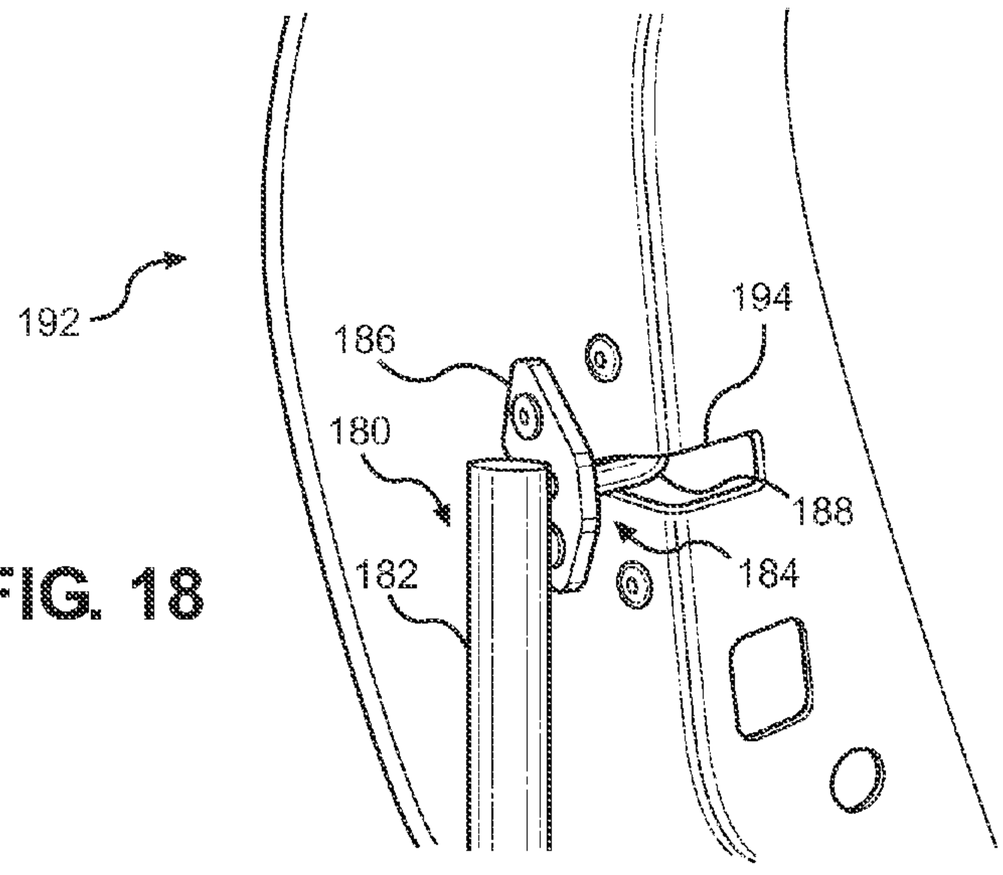


FIG. 18

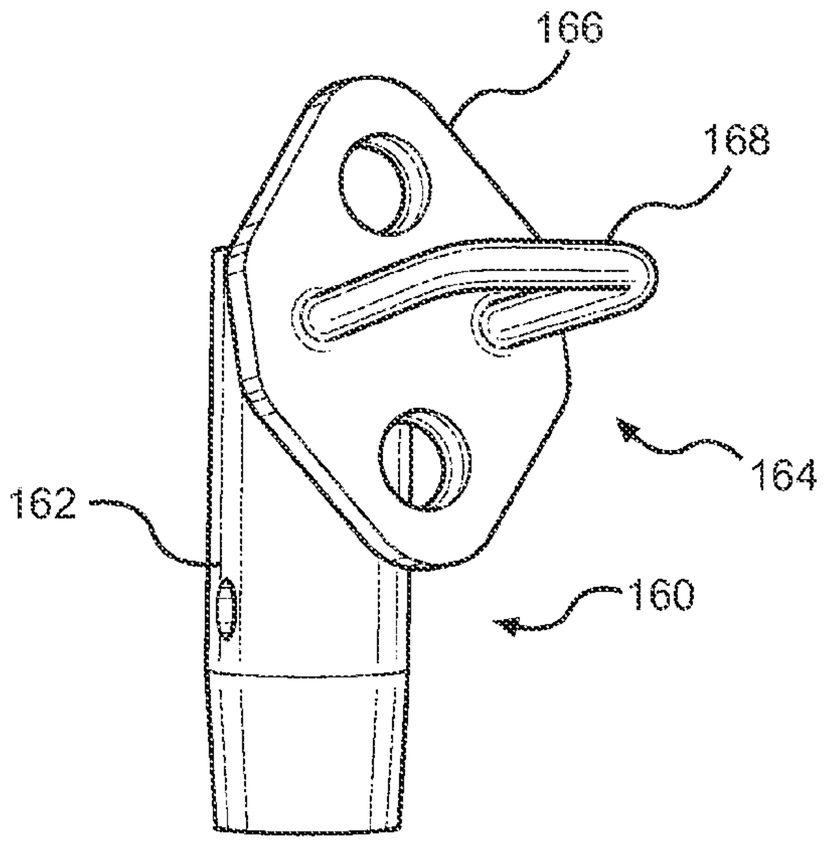


FIG. 19

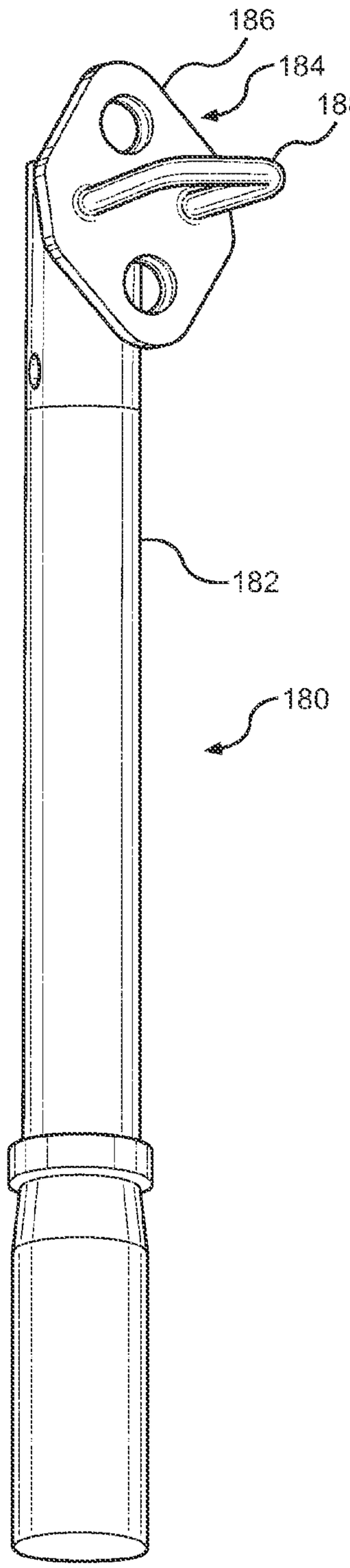


FIG. 20

APPARATUS FOR ADJUSTING RELATIVE ORIENTATIONS OF COMPONENTS, AND METHODS OF USE AND MANUFACTURE THEREOF

BACKGROUND

The disclosed subject matter relates to apparatus for adjusting relative orientations of components, and methods of use and manufacture thereof. More particularly, the disclosed subject matter relates to methods and apparatus for adjusting physical components in a manufacturing or assembly context, such as with regard to enhancing alignment of a vehicle door relative to other components, such as those defining a door opening, those related to door closure (e.g., a striker), etc.

Many types of vehicles, such as those that travel on land, through water, by air, etc., define doors or door openings to allow ingress and egress of vehicle occupants. Some such vehicles include a single door, while others may include multiple doors. The doors can be configured to be opened and closed so that when they are opened, an occupant can enter and exit the vehicle, while when they are closed, the occupant is confined within the vehicle.

SUMMARY

Certain manufacturing tolerances may be relevant to fitting or installing vehicle doors within the associated door opening or with regard to other components, such as those relevant to door closure (e.g., door striker), etc. For example, a door opening may be defined by a certain structure into which the door must be fit with a sufficient tolerance to enable the door to be secured. It may also be beneficial for this tolerance to be sufficient to impede or prevent air, water, debris, etc. from penetrating a gap formed between the door and components defining the door opening (e.g., door frame), which could then travel into an interior of the vehicle. Still further, the door may need to be in a specific position to enable the door to be secured in place, such as by latching with components disposed on the vehicle body.

However, it may be difficult to fit or otherwise install vehicle doors in the door opening relative to the door frame while satisfying appropriate tolerances, especially in the context of mass production, e.g., a vehicle assembly line. For example, after the doors have been assembled and attached to the door frame at the door openings, gaps defined around the door periphery and the door frame may be checked to determine whether or not they satisfy the appropriate tolerances.

This tolerance checking may be relevant or beneficial at various stages of the manufacturing or assembly processes, such as after completion of the vehicle assembly process and at final checkout, i.e., a step in the process where final adjusting and fine tuning (fit and finish) of the vehicle occurs. If the tolerances are not met, such as where the height of the door is off, then the door can be manually adjusted up or down by pulling or pushing, which results in deforming a part of an attachment mechanism of the door to satisfy the tolerances. For example, a technician may pull the door with their arms to lower the door relative to the door frame, or alternatively pull up on the door with their leg and back muscles to raise the door relative to the door frame.

However, the aforementioned operation of manually adjusting the door can be inconvenient and difficult, and also

may even be inaccurate. In addition, these movements may create awkward stresses on the technician's body, leading to potential injuries.

Thus it may be beneficial to provide methods and apparatus that address at least one of the above issues. For example, it may be beneficial to provide methods and apparatus to reduce or eliminate the awkward movements, stresses, etc. on the technician's body disclosed above. Instead of a technician using back and arm muscles, it may be beneficial to provide an apparatus that enables this operation to be performed by using the technician's leg muscles to perform this raising and/or lowering of the door relative to the door frame. As one exemplary embodiment, pedals can be used that are configured to be pushed with the technician's foot, such as where pushing one pedal raises the door relative to the door frame, and pushing another pedal pulls the door downwardly to lower the door relative to the door frame.

In accordance with one exemplary operation, the apparatus disclosed above (such as a door adjust apparatus) may be used when a vehicle is disposed at a location in the manufacturing/assembly process where a final weld adjust is performed. A determination can be made as to whether the door is in or out of specification, i.e., whether the tolerances between the door and the door frame are acceptable. If the door is determined to be out of specification, then the technician can connect the door adjust apparatus to the vehicle door, such as by closing the door on a simulated door component (i.e., door striker) of the apparatus. The technician may then press the appropriate pedal of the apparatus with the technician's foot to either raise or lower the door relative to the door frame. The apparatus can be configured to enable the technician to raise or lower the door by a desired amount, such as by pushing the relevant pedal a certain amount, number of times, with a certain amount of force, etc.

Some embodiments are therefore directed to an adjuster for adjusting a position of a vehicle door relative to other vehicle components. The vehicle can include a striker that is configured to communicate with and be held by a latch of the door to enable the door to be held in a fully closed position. The vehicle can also include a release mechanism that enables the striker to be released from the latch to thereby enable the door to be released from the fully closed position and maneuvered into an open position. The adjuster can include a bar that is configured to be held by the vehicle door latch so as to form a rigid connection between the bar and the vehicle door. The bar can also be configured to be released from the vehicle door latch upon actuation of the vehicle release mechanism. A frame can be supported by a surface that is static relative to the vehicle. An actuator can connect the frame to the bar. The actuator can be configured to enable the vehicle door to be manually raised or lowered by a predetermined distance that facilitates the vehicle door adopting a position that provides enhanced communication between the vehicle door latch and the vehicle striker.

Some other embodiments are directed to a method of manufacturing an adjuster for adjusting a position of a vehicle door relative to other vehicle components. The vehicle can include a striker that is configured to communicate with and be held by a latch of the door to enable the door to be held in a fully closed position. The vehicle can also include a release mechanism that enables the striker to be released from the latch to thereby enable the door to be released from the fully closed position and maneuvered into an open position. The method of manufacturing can include: configuring a bar to be held by the vehicle door latch so as

to form a rigid connection between the bar and the vehicle door, the bar also being configured to be released from the vehicle door latch upon actuation of the vehicle release mechanism; connecting the bar to a frame with an actuator; and configuring the actuator to enable the vehicle door to be manually raised or lowered by a predetermined distance that facilitates the vehicle door adopting a position that provides enhanced communication between the vehicle door latch and the vehicle striker.

Still other embodiments are directed to a method of adjusting a position of a vehicle door relative to other vehicle components. The vehicle can include a striker that is configured to communicate with and be held by a latch of the door to enable the door to be held in a fully closed position. The vehicle can also include a release mechanism that enables the striker to be released from the latch to thereby enable the door to be released from the fully closed position and maneuvered into an open position. The method can include: opening the vehicle door; moving an adjuster to be proximate the open vehicle door and so as to be supported on a surface that is static relative to the vehicle door; maneuvering a bar of the adjuster so as to be held by the vehicle door latch so as to form a rigid connection between the bar and the vehicle door; manually operating an actuator of the adjuster so as to raise or lower the bar to thereby enable the vehicle door to be raised and lowered by a predetermined distance that facilitates the vehicle door adopting a position that provides enhanced communication between the vehicle door latch and the vehicle striker; and actuating the vehicle release mechanism so that the bar is released from the vehicle door latch after the vehicle door has been positioned to achieve enhanced communication between the vehicle door latch and the vehicle striker.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed subject matter of the present application will now be described in more detail with reference to exemplary embodiments of the apparatus and method, given by way of example, and with reference to the accompanying drawings, in which:

FIG. **1** is a perspective view of an exemplary vehicle door adjuster in accordance with the disclosed subject matter.

FIG. **2** is a perspective view of the exemplary vehicle door adjuster of FIG. **1** in use with an exemplary vehicle.

FIG. **3** is a perspective view of an exemplary connection pin of the vehicle door adjuster of FIG. **2** engaged with an exemplary latch slot of the vehicle door.

FIG. **4** is a perspective view of the exemplary connection pin of FIG. **2** at a higher position on the vehicle door adjuster in accordance with the disclosed subject matter.

FIG. **5** is a perspective view of the exemplary connection pin of FIG. **2** at a lower position on the vehicle door adjuster in accordance with the disclosed subject matter.

FIG. **6** is a front view of the exemplary vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **7** is a side view of the exemplary vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **8** is a top view of the exemplary vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **9** is a perspective view of an exemplary frame of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **10** is a perspective view of an exemplary guide block of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **11** is a perspective view of an exemplary adjusting rod of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **12** is a side view of the exemplary adjusting rod of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **13** is a perspective view of an exemplary lowering pedal of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **14** is a perspective view of an exemplary raising pedal of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **15** is a perspective view of an exemplary caster assembly of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **16** is a perspective view of a lower portion of an alternative embodiment of the vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

FIG. **17** is a perspective view of an alternate embodiment of the vehicle door adjuster of FIG. **1** in use with the exemplary vehicle.

FIG. **18** is a perspective view of an exemplary rear striker of the vehicle door adjuster of FIG. **17** engaged with the exemplary latch slot of the vehicle door.

FIG. **19** is a perspective view of an exemplary front door extension in accordance with the disclosed subject matter.

FIG. **20** is a perspective view of the exemplary rear door extension of FIG. **17** in accordance with the disclosed subject matter.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

A few inventive aspects of the disclosed embodiments are explained in detail below with reference to the various figures. Exemplary embodiments are described to illustrate the disclosed subject matter, not to limit its scope, which is defined by the claims. Those of ordinary skill in the art will recognize a number of equivalent variations of the various features provided in the description that follows.

Certain embodiments of a vehicle door adjuster **10** are disclosed below, and FIGS. **1-16** illustrate some of these embodiments. However, embodiments are intended to include or otherwise cover many different embodiments and structures for determining whether certain vehicular components are placed at acceptable relative positions upon assembly.

I. Overall Features of Exemplary Vehicle Door Adjuster

FIG. **1** is a perspective view of an exemplary vehicle door adjuster **10** in accordance with the disclosed subject matter.

As shown in FIG. **1**, and in more detail in FIG. **15**, the vehicle door adjuster **10** includes caster assemblies **20** at a bottom portion of the vehicle door adjuster **10** that contact a surface on which the vehicle door adjuster **10** is supported, such as the ground. In the present embodiment, one of the caster assemblies **20** is positioned at each of four corners of the bottom portion of the vehicle door adjuster **10**. However, other embodiments can include any number of caster assemblies **20**, such as five, three, two, or even no caster assem-

blies **20**. In the instance where no caster assemblies **20** are included, alternative support assemblies such as feet may be added.

The caster assemblies **20** support the vehicle door adjuster **10**, and allow the vehicle door adjuster **10** to be easily moved along a surface, such as the ground. As indicated above, other structures may be used to perform support and movement operations of the vehicle door adjuster **10**.

Each of the caster assemblies **20** contacts the ground surface via a wheel **26** retained within the corresponding caster assembly **20**. Each wheel **26** in the exemplary embodiment is cylindrical in shape, and retained via a wheel axle **28** inserted through a center of the wheel **26**. However, other types of wheels **26**, such as spheres or balls can also be used. Additionally, grooves matched to an outer surface of the wheel **26** can be used instead of a wheel axle **28** to retain each wheel **20**, such as in a ball bearing-type setup.

The wheels **26** serve to provide low rolling resistance when moving the vehicle door adjuster **10** along a surface, such as the ground. As indicated above, other structures may be used to achieve low rolling resistance when moving the vehicle door adjuster **10**.

Each wheel **26** is retained within a caster housing **24** of the corresponding caster assembly **20**. The caster housing **24** surrounds a portion of the wheel **26** and defines holes in opposing sides through which the wheel axle **28** in inserted. The wheel axle **28** passes through a center of the wheel **26** to hold the wheel **26** in place. However, a type of caster housing **24** that does not require the wheel axle **28** can alternatively be used, such as a housing with grooves to retain the wheel **26**, as in the aforementioned ball bearing-type setup.

Each caster housing **24** serves to retain the wheel **26** within the corresponding caster assembly **20** and facilitate rotation of the wheel **26**. As indicated above, other structures may be used to retain and facilitate rotation of the wheels **26**.

A caster assembly shaft **22** is attached to a top side of each caster housing **24**. The caster assembly shaft **22** extends upward and away from the ground surface. The caster assembly shaft **22** in the exemplary embodiment is cylindrical in shape, but can also be other shapes such as a rectangular prism. The caster assembly **20** can also lack a caster assembly shaft **22** altogether. When included, each caster assembly shaft **22** can be attached to a center of the top side of the caster housing **24**. Alternatively, each caster assembly shaft **22** can be attached at any other position of the caster housing **24**. The caster assembly shaft **22** can be attached to the caster housing **24** via welding, through use of adhesives, or attachment fixtures such as screws and bolts, etc.

Upper portions of each caster assembly shaft **22** can be attached to a frame **40**, such as to enable rotation, which is described below. The caster assembly shafts **22** are inserted into recesses in a frame **40**, which secures attachment between the caster assembly shafts **22** and the frame **40** while allowing the caster assemblies **20** to pivot about the caster assembly shafts **22**. The caster assembly shafts **22** can be press-fitted into the recesses in the frame **40**, or may alternatively be attached through use of attachment fixtures, such as screws and bolts, etc.

In some embodiments, the caster assembly shafts **22** can be rigidly fixed to the frame **40** and unable to rotate. Rigidly fixed caster assembly shafts **22** may be attached to the frame **40** via welding, through use of adhesives, or attachment fixtures such as screws and bolts, etc. Furthermore, an embodiment may have some rotatably attached caster assembly shafts **22** and some rigidly fixed caster assembly shafts **22**.

Additionally, the upper portions of each caster assembly shaft **22** are slideably inserted into the recesses in the frame **40**, such that the caster assembly shafts **22** can move up and down within a vertical space defined by each recess. The caster assembly shafts **22** can be slid up into the corresponding recesses to fill the vertical space, thereby bringing the frame **40** closer to the wheels **26**. Consequently, such movement of the caster assembly shafts **22** within the recesses of the frame **40** brings the vehicle door adjuster **10** closer to a surface such as the ground. Conversely, the caster assembly shafts **22** can be slid down within the corresponding recesses to open up the vertical space, thereby moving the frame **40** farther from the wheels **26**. Consequently, such movement of the caster assembly shafts **22** within the recesses of the frame **40** moves the vehicle door adjuster **10** farther from a surface such as the ground. The movement of each caster assembly shaft **22** within the corresponding recesses of the frame **40** is facilitated by a caster spring **30**, which is described below.

Alternatively, the caster assembly shafts **22** can be telescoping so that a top portion slides into a recess within a bottom portion of each caster assembly shaft **22**. The bottom portion can likewise be configured to slide into the top portion of each caster assembly shaft **22** to maintain the telescoping function.

The caster assembly shafts **22** support the frame **40** on the corresponding caster assemblies **20**, and permit the caster assemblies **20** to rotate. By supporting the frame **40**, the caster assembly shafts **22** elevate the frame **40** above a surface, such as the ground. Furthermore, the caster assembly shafts **22** allow the vehicle door adjuster **10** to be moved more easily because the caster assemblies **20** can be rotated to guide the vehicle door adjuster **10** along a surface such as the ground. As indicated above, other structures may be used to support the caster assemblies **20** on the frame **40**, and to permit the caster assemblies **20** to rotate.

Additionally, because the caster assembly shafts **22** are slideably inserted within recesses in the frame **40**, the vehicle door adjuster **10** can be brought closer to or moved farther away from a surface such as the ground. The vehicle door adjuster **10** being brought closer to the ground allows grounding extensions **42** and **44** to contact the ground and stabilize the vehicle door adjuster **10**, as detailed below. When the vehicle door adjuster **10** is moved farther away from the ground, the frame **40** moves away from the ground and the grounding extensions **42** and **44** cannot contact the ground, permitting the vehicle door adjuster **10** to be transported freely. As indicated above, other structures may be used to move the vehicle door adjuster **10** closer to and farther away from a surface such as the ground.

The caster spring **30** can extend around the caster assembly shaft **22** approximately the length of (and so as to be coaxial with) the caster assembly shaft **22**. The caster spring **30** contacts the top side of the caster housing **24** at one end, and contacts a bottom side of the frame **40**, which will be described below, at the other end. An elastic member, such as a rubber stoppers can alternatively be used instead of the caster spring **30**. Furthermore, some embodiments do not include any spring or elastic member.

Each caster spring **30** serves to bias the caster assembly shaft **22** within the corresponding caster assembly **20** to extend farther from a bottom of the frame **40** and therefore push the frame **40** farther away from the ground. By moving the frame **40** farther away from the ground, the caster

springs **30** facilitate a loss of contact between the grounding extensions **42** and **44** to thereby enable the vehicle door adjuster **10** to be freely transported along the ground. As indicated above, other structures may be used to bias relative positions of the caster assembly shafts **22** within corresponding recesses of the frame **40**.

In the present embodiment, the frame **40** of the vehicle door adjuster **10** is attached to tops of the caster assembly shafts **22**. The frame **40** can be metal, plastic, or an alloy or composite. The frame **40** has a rectangular perimeter, however the perimeter can also be circular, triangular or otherwise polygonal. The frame **40** can be attached to the caster assembly shafts **22** by welding, use of adhesives or attachment fixtures such as screws or bolts, etc. The caster assembly shafts **22** are attached at each of the four corners of the frame **40**, however the caster assembly shafts **22** can be attached to any parts of the frame.

The frame **40** serves to provide overall structure and support for the vehicle door adjuster **10**. As indicated above, other configurations may be used to achieve structure and support of the vehicle door adjuster **10**.

Grounding extensions **42** and **44** are attached to a bottom side of the frame **40** and extend towards a surface, such as the ground. The grounding extensions **42** and **44** are attached to the frame **40** by welding, use of adhesives or attachment fixtures such as screws or bolts, etc. The grounding extensions **42** and **44** have flat bottoms extending along sides of the frame **40** and are attached to the frame **40** by two legs. The flat bottoms of the grounding extensions **42** and **44** each have a width equal to a width of the sides of the frame **40**. Alternatively the flat bottoms of the grounding extensions **42** and **44** can be wider or thinner than the sides of the frame **40**. The grounding extensions **42** and **44** are positioned on opposing sides of the frame **40**, but can be positioned along any portion of the frame **40**.

The grounding extensions **42** and **44** serve to provide stability for the vehicle door adjuster **10** during use. As indicated above, other structures may be used to achieve stability of the vehicle door adjuster **10**.

The frame **40** also has a pedal crossbar **46** and a rod crossbar **48**, each extending through an interior of the frame **40** to connect opposing sides of the frame **40**. The pedal crossbar **46** and the rod crossbar **48** are spaced apart and extend parallel to one another, while being perpendicular to the frame **40** at the connection points. The pedal crossbar **46** and the rod crossbar **48** extend perpendicular to the grounding extensions **42** and **44**, however the pedal crossbar **46** and the rod crossbar **48** can also extend parallel to the grounding extensions **42** and **44**. The pedal crossbar **46** and the rod crossbar **48** may be formed from metal, plastic, or another alloy or composite and can be attached to the frame **40** by welding, use of adhesives or fixtures such as screws or bolts, etc.

A pedal post **50** is attached to a center of a top side of the pedal crossbar **46**. The pedal post **50** is rectangular in cross section, but may also be formed as a cylinder or otherwise. The pedal post **50** extends upwards away from the ground surface and is attached to the pedal crossbar **46** by welding, use of adhesives or fixtures such as screws or bolts, etc. The pedal post **50** can be formed from metal, plastic, or any another alloy or composite. The pedal post **50** also has a post pin **52** extending through a hole in the pedal post **50** parallel to the pedal crossbar **46**.

The pedal crossbar **46**, rod crossbar **48** and pedal post **50** serve to connect operative elements of the vehicle door adjuster **10** to the frame **40**. As indicated above, other structures may be used to connect operative elements of the vehicle door adjuster **10**.

Also as shown in more detail in FIG. **9**, an adjusting rod guide extension **132** is attached to a center of a top side of the rod crossbar **48**. The adjusting rod guide extension **132** is cylindrical, but may also be formed with a rectangular or otherwise polygonal cross section. The adjusting rod guide extension **132** extends upward from the rod crossbar **48** and is attached by welding, use of adhesives or fixtures such as screws or bolts, etc. The adjusting rod guide extension **132** is formed from metal, plastic, or another alloy or composite. In the present embodiment, the adjusting rod guide extension **132** extends to a height less than that of a height of the pedal post **50**, however the adjusting rod guide extension **132** can also extend to the same height as the pedal post **50**, or even a greater height.

The adjusting rod guide extension **132** serves to provide support for and align an adjusting rod **130** that is described below. As indicated above, other structures may be used to provide support for and align the adjusting rod **130** along a path of movement of the adjusting rod **130**.

An end of the aforementioned post pin **52** is rotatably connected to a raising pedal **60**, while another end of the post pin **52** is rotatably connected to a lowering pedal **80**. In this manner, the post pin **52** rotatably connects both the raising pedal **60** and the lowering pedal **80** to the pedal post **50**. However, the raising pedal **60** and the lowering pedal **80** can also be connected to the post pin **52** via separate and distinct members.

The post pin **52** serves to connect the raising pedal **60** and the lowering pedal **80** to the frame **40**. As indicated above, other structures may be used to connect the raising pedal **60** and the lowering pedal **80**.

As shown in more detail in FIG. **14**, the raising pedal **60** includes a raising pedal platform **64** attached to an end of a raising beam **62**. The raising pedal platform **64** can be attached to the raising beam **62** by welding, use of adhesives or attachment fixtures such as screws or bolts, etc. In the present embodiment, the raising pedal platform **64** is rectangular, however the raising pedal platform **64** can also be circular or otherwise polygonal. Furthermore, some embodiments do not include any raising pedal platform **64**. The raising beam **62** also has a raising post slot **66** through which the post pin **52** is inserted to rotatably connect the raising pedal **60** and the pedal post **50**. The raising post slot **66** is formed at an intermediate portion of the raising beam **62**. The raising beam **62** includes an adjusting rod hole **68** at an end opposite the raising pedal platform **64** through which a base pin **70** extends to rotatably connect the raising beam **62** to the adjusting rod **130** that will be described below.

The raising pedal **60** allows a user to raise the adjusting rod **130** and consequently raise a vehicle door. As indicated above, other structures may be used to raise the adjusting rod **130**.

As shown in more detail in FIG. **13**, the lowering pedal **80** includes a lowering pedal platform **84** attached to an end of a lowering beam **82**. The lowering pedal platform **84** can be attached to the lowering beam **82** by welding, use of adhesives or attachment fixtures such as screws or bolts, etc. In the present embodiment, the lowering pedal platform **84** is rectangular, however the lowering pedal platform **84** can also be circular or otherwise polygonal. Furthermore, some embodiments do not include any lowering pedal platform **84**. The lowering beam **82** also has a lowering post hole **86** through which the post pin **52** is inserted to rotatably connect the lowering pedal **80** and the pedal post **50**. The lowering

post hole **66** is formed at an intermediate portion of the lowering beam **82**. The lowering beam **82** also includes an intermediate hook **88** and an end hook **90**, which are connected to opposing ends of a cable **150** that will be described below.

The lowering pedal **80** allows a user to lower the adjusting rod **130** by pulling down on a cable **150** connected to the adjusting rod **130**, thereby lowering a vehicle door. As indicated above, other structures may be used to lower the adjusting rod **130**.

The intermediate hook **88** is attached to a top surface of the lowering beam **82** at an intermediate position between the lowering pedal platform **84** and the post pin **52**. The intermediate hook **88** can be attached to the lowering beam **82** by welding, use of adhesives or fixtures such as screws or bolts, etc. Alternatively, the intermediate hook **88** can be formed as an eyelet, an open-ended hook, a slit or hole in the lowering beam **82**, or another attachment structure.

The intermediate hook **88** serves to attach an end of the cable **150** to an intermediate portion of the lowering pedal **80**. As indicated above, other structures may be used to attach the cable **150** to the intermediate portion the lowering pedal **80**.

The end hook **90** is attached to a bottom surface of the lowering beam **82** at an end opposite the lowering pedal platform **84**. The end hook **90** can be attached to the lowering beam **82** by welding, use of adhesives or fixtures such as screws or bolts, etc. Additionally, the end hook **90** can be formed as an eyelet, an open-ended hook, a slit or hole in the lowering beam **82**, or another attachment structure.

The end hook **90** serves to attach another end of the cable **150** to an end portion of the lowering pedal **80**. As indicated above, other structures may be used to attach the cable **150** to the end portion of the lowering pedal **80**.

The present embodiment also has a post brace **100** and a frame brace **106** extending from the pedal post **50** and the frame **40**, respectively. Alternative embodiments may have more or fewer braces, and braces may extend from other locations of the frame **40**.

The post brace **100** is attached to a top of the pedal post **50** and extends upward to connect to a side of a guide block **112** by a first pin **114**. The guide block **112** is centered above the rod crossbar **48**, and is also connected to the frame **40** via the frame brace **106**. The frame brace **106** is attached to a perimeter section of the frame **40** and extends upward to connect to an opposing side of the guide block **112** via a second pin **116**. The post brace **100** and frame brace **106** connect to opposing sides of the guide block **112**. The post brace **100** and frame brace **106** can, however, connect to the same side of the guide block **112** in an alternative embodiment.

The post brace **100** and the frame brace **106** serve to support the guide block **112** and thereby facilitate controlled movement of the adjusting rod **130**. As indicated above, other structures may be used to support the guide block **112** and control adjusting rod **130** movement.

Also as shown in more detail in FIG. **10**, the guide block **112** has two halves **118** and **120** joined together via the first pin **114** and the second pin **116**, with ends of the post brace **100** and the frame brace **106** sandwiched between the two halves **118** and **120** at the respective pins **114**, **116**. Because of this joinder, the two halves **118** and **120** of the guide block **112** are spaced apart by a gap equivalent to a thickness of the ends of the post brace **100** and the frame brace **106** that are sandwiched between the two halves **118** and **120**. The two halves **118** and **120** may also be joined together by a greater or fewer number of pins, or by another mechanism such as adhesion or welding. The two halves **118** and **120** of the guide block **112** have contoured inner surfaces that define a hole extending through a center of the guide block **112** to facilitate the passing through of the adjusting rod **130**. The contoured inner surfaces of the two halves **118** and **120** can be substantially semi-cylindrical or otherwise concave.

The guide block **112** serves to guide the adjusting rod **130** as the adjusting rod **130** moves up and down via actuation of the raising pedal **60** and the lowering pedal **80**. As indicated above, other structures may be used to guide movement of the adjusting rod **130**.

The aforementioned adjusting rod **130** is cylindrical and extends from the rod crossbar **48** to a point above the guide block **112** at a top portion of the vehicle door adjuster **10**, with an intermediate portion of the adjusting rod **130** passing through the hole through the center of the guide block **112**. A base of the adjusting rod **130** is hollow and surrounds a portion of the adjusting rod guide extension **132** at the center of the rod crossbar **48**. A rod spring **134** extends around an exposed portion of the adjusting rod guide extension **132** that is not surrounded by the adjusting rod **130**. An end of the rod spring **134** abuts the top surface of the rod crossbar **48**, while an opposite end of the rod spring **134** abuts a base of the adjusting rod **130**. An elastic member other than the rod spring **134** may be used, such as a rubber stopper. Further, some embodiments do not include any spring or elastic member.

As shown in more detail in FIG. **11**, the adjusting rod **130** also includes the base pin **70** extending perpendicular from the base of the adjusting rod **130** and through the adjusting rod hole **68** of the raising beam **62**. The base pin **70** is cylindrical and rotatably connects the adjusting rod **130** to the raising beam **62**.

The adjusting rod **130** serves to transfer movement of the raising pedal **60** and the lowering pedal **80** to movement of a vehicle door. As indicated above, other structures may be used to transfer user input to movement of the vehicle door.

As shown in more detail in FIGS. **6** and **7**, the adjusting rod **130** has a first guide **136** and a second guide **138** extending along opposing sides of the adjusting rod **130**. The first guide **136** and the second guide **138** are formed as ridges along a length of the adjusting rod **130**, and are slideably engaged with the gap formed between the two halves **118** and **120** of the guide block **112**. The first guide **136** and the second guide **138** of the present embodiment do not extend the entire length of the adjusting rod **130**, however they may be configured to do so.

A rod hook **140** is disposed proximate a distal end of the adjusting rod **130** opposite the base. The cable **150** is passed through the rod hook **140**. The rod hook **140** can be formed as an eyelet, an open-ended hook, a slit or hole in the adjusting rod **130**, or another attachment structure.

The first guide **136** and the second guide **138** serve to align and guide movement of the adjusting rod **130** in up and down directions through the guide block **112**. The rod hook **140** serves to connect the cable **150** to the adjusting rod **130** so that pulling down on the cable **150** moves the adjusting rod **130** down. As indicated above, other structures may be used to guide and move the adjusting rod **130** up and down.

The adjusting rod **130** also has a pair of extension holes **144** extending through a center of the top portion of the adjusting rod **130**. The pair of extension holes **144** includes an upper extension hole **144** and a lower extension hole **144** at relative positions along the adjusting rod **130**. A distance separating the pair of extension holes **144** is approximately defined by a difference in height between a rear door latch

and a front door latch of the vehicle **190**. There can also be just one extension hole, or a number in excess of two such as three, four, five, etc. with varying separation distances. Additionally, the pair of extension holes **144** can extend perpendicular to the direction of elongation of the adjusting rod **130**, and can be oriented to align with an elongated portion of the rod hook **140**.

An connection pin **142** is inserted through either the upper or lower extension hole **144** and protrudes so as to be engageable with a latch protrusion (not shown) of a vehicle door, as described below. The connection pin **142** is substantially cylindrical, and is formed so as to be retained within the pair of extension holes **144**. Therefore, the connection pin **142** may be a spring pin or may have locking clips to keep the spring pin **142** in place.

The aforementioned cable **150** can be woven metal or metal alloys, or alternatively may be made of rope or other fibrous materials. The cable **150** is passed through the rod hook **140** and attached to the intermediate hook **88** of the lowering beam **82** at an end of the cable **150**. The other end of the cable **150** is passed around the rod crossbar **48** and attached to the end hook **90** of the lowering beam **82**. Specifically, the other end of the cable **150** passes below the frame **40** through a space between the rod crossbar **48** and a front end of the perimeter of the frame **40**, and is then looped around an underside of the rod crossbar **48** so as to pass above the frame **40** through a space between the rod crossbar **48** and the pedal crossbar **46**, the other end of the cable **150** ultimately terminating at the end hook **90** to which it is attached. The other end of the cable **150** may alternatively be looped around different components of the frame **40** before being attached to the end hook **90**, such as the pedal crossbar **46**.

Because the cable **150** is connected to the lowering pedal **80** and the adjusting rod **130**, the cable **150** serves to lower the adjusting rod **130** by transferring movement of the lowering pedal **80**. As indicated above, other structures may be used transfer movement of the lowering pedal **80** to the adjusting rod **130**.

As shown in more detail in FIGS. **2-5**, the connection pin **142** can be removably inserted into the upper or lower extension holes **144** at the top portion of the adjusting rod **130**.

The connection pin **142** serves to engage the adjusting rod **130** with the vehicle door so that movement of the adjusting rod **130** moves the vehicle door up or down. However, other structures may be used to engage the adjusting rod **130** with the vehicle door.

II. Vehicle Door Adjuster with Vehicle Door

FIG. **2** is a perspective view of the exemplary vehicle door adjuster of FIG. **1** in use with an exemplary vehicle. FIG. **2** particularly illustrates an embodiment of the vehicle door adjuster **10**, made in accordance with the principles of the disclosed subject matter, in use with a vehicle **190**. As shown, the vehicle **190** has a rear door **192** that is in an open position. The rear door **192** includes a latch slot **194** configured to engage with a vehicle striker (not shown) when the rear door **192** is closed. When the rear door **192** is in the open position, the latch slot **194** is free to engage with the connection pin **142** of the vehicle door adjuster **10**, as described below.

In operation, the vehicle door adjuster **10** is moved along the surface on which it is supported to a position adjacent the rear door **192**. The vehicle door adjuster **10** can be moved manually or automatically, and can be rolled, slid, or carried.

Properly positioning the vehicle door adjuster **10** serves to allow alignment of the connection pin **142** with the latch slot **194**, and makes it easier to adjust the rear door **192**, and in particular requires less force for the adjustment. As indicated above, other structures may be used to align the connection pin **142** to the latch slot **194**, and facilitate adjustment of the rear door **192**.

Once properly positioned, the vehicle door adjuster **10** can be pressed toward the surface on which it is supported so that the grounding extensions **42** and **44** contact the surface. The pressing force must overcome the resistance of the caster springs **30** included in each caster assembly **20** in order for the vehicle door adjuster **10** to lower towards the surface. As the caster springs **30** are compressed, each caster assembly shaft **22** slides into corresponding vertical recesses of the frame **40**, thereby bringing the vehicle door adjuster **10** closer to the surface. The vehicle door adjuster **10** can be pressed toward the surface by manual or automatic force exerted downward on the frame **40**, grounding extensions **42** and **44**, or any other structural component. In an embodiment that does not include caster assemblies **20**, the vehicle door adjuster **10** is not pressed toward the surface and instead contacts the surface via feet or another static component.

Pressing the vehicle door adjuster **10** toward the surface on which it is supported serves to stabilize and support the vehicle door adjuster **10** while being operated. As indicated above, other structures may be used to stabilize and support the vehicle door adjuster **10**.

While the vehicle door adjuster **10** is pressed toward the surface, the raising pedal **60** and the lowering pedal **80** can then each be pressed (such as by the user's foot) separately to modulate an appropriate height of the adjusting rod **130** to the extent necessary to vertically align the connection pin **142** with the latch slot **194** of the rear door **192**. An initial height of the connection pin **142** determines whether the adjusting rod **130** needs to be moved up or down to align the connection pin **142** with the latch slot **194**, and consequently, whether the raising pedal **60** or the lowering pedal **80** is pressed. Alternatively, the adjusting rod **130** can be moved up or down directly without pressing on either the raising pedal **60** or the lowering pedal **80** because the vehicle door adjuster **10** is not yet attached to the rear door **192**.

Adjusting a height of the adjusting rod **130** serves to align the connection pin **142** with the latch slot **194** of the rear door **192** before the vehicle door adjuster **10** is engaged with the rear door **192**. As indicated above, other mechanisms may be used to vertically align the connection pin **142** with the latch slot **194**.

Once aligned at an appropriate height, the connection pin **142** and the latch slot **194** of the rear door **192** are engaged. The connection pin **142** is inserted into the latch slot **194** and the latch protrusion engages with the connection pin **142**. The connection pin **142** and the latch slot **194** are therein secured together such that movement of one corresponds to movement of the other.

Engaging the connection pin **142** of the adjusting rod **130** with the latch slot **194** of the rear door **192** serves to physically connect the vehicle door adjuster **10** to the rear door **192**, thereby allowing a transfer of force between the two. As indicated above, other structures may be used to engage the adjusting rod **130** with the rear door **192**.

Once the connection pin **142** and the rear door **192** are engaged, the raising pedal **60** and the lowering pedal **80** can then each be pressed (such as by the user's foot) separately to raise or lower the adjusting rod **130** to simultaneously raise or lower the rear door **192**. The rear door **192** is raised

or lowered a distance corresponding to that which the adjusting rod **130** is raised or lowered by operation of the raising pedal **60** and the lowering pedal **80**.

After adjusting the rear door **192** to a desirable height, the connection pin **142** can be disengaged from the latch slot **194**. Pulling a door handle of the rear door **192** releases the latch protrusion from the connection pin **142**, freeing the connection pin **142**.

The vehicle door adjuster **10** is then moved along the surface on which it is supported away from the rear door **192** of the vehicle **190**. With the vehicle door adjuster **10** out of the way and a height of the rear door **192** having been appropriately adjusted, the rear door **192** can be closed correctly so as to prevent potential wind noise or water leaks and achieve fit and finish standards

III. Rear Striker with Rear Door Latch Slot

FIG. **3** is a perspective view of an exemplary connection pin of the vehicle door adjuster of FIG. **2** engaged with an exemplary latch slot of the vehicle door.

As shown in FIG. **3**, the connection pin **142** is vertically aligned with the latch slot **194** of the rear door **192**. The connection pin **142** extends into the latch slot **194** and engages with the latch protrusion (not shown) within an interior of the latch slot **194**. Top and bottom sides of the connection pin **142** abut against upper and lower portions of the latch slot **194** in the engaged state. When the connection pin **142** is moved up or down by virtue of the adjusting rod **130** being moved up or down, the connection pin **142** pushes up or down on the latch slot **194** and thereby moves the rear door **192**.

The connection pin **142** serves to engage the vehicle door adjuster **10** with the rear door **192** of the vehicle **190**, and enables subsequent adjustment of the rear door **192**. As indicated above, other structures may be used to engage and adjust the rear door **192**.

IV. Upper and Lower Connection Pin Positions

FIG. **4** is a perspective view of the exemplary connection pin of FIG. **2** at a higher position on the vehicle door adjuster in accordance with the disclosed subject matter.

As shown in FIG. **4**, the connection pin **142** of the present embodiment is inserted through the upper extension hole **144** of the top portion of the adjusting rod **130**. The upper extension hole **144** is aligned with and positioned above the lower extension hole **144**, which is described below. As discussed, this difference in height of the pair of extension holes **144** is due to the fact that the latch slot **194** of the rear door **192** is higher than the latch slot of the front door (not shown), and the connection pin **142** therefore must be positioned higher on the adjusting rod **130** when engaging with the latch slot **194** of the rear door **192**. However, the pair of extension holes **144** may be replaced by a single extension hole, and the extension hole that aligns with the latch slot **194** of the rear door **192** may in fact be lower on the adjusting rod **130** than the extension hole that aligns with the latch slot of the front door.

The connection pin **142** serves to configure the adjusting rod **130** so that the vehicle door adjuster **10** may interact with the latch slot **194** of the rear door **192**. As indicated, other structures may be used to configure the adjusting rod **130**.

FIG. **5** is a perspective view of the exemplary connection pin of FIG. **2** at a lower position on the vehicle door adjuster in accordance with the disclosed subject matter.

As shown in FIG. **5**, the connection pin **142** of the present embodiment is inserted through the lower extension hole **144** of the top portion of the adjusting rod **130**. The lower extension hole **144** is aligned with and positioned below the upper extension hole **144**, which is described above. This difference in height of the pair of extension holes **144** is due to the fact that a latch slot of a front door is lower than the latch slot **194** of the rear door **192**, and the connection pin **142** therefore does not need to be positioned as high on the adjusting rod **130** when engaging with the latch slot of the front door. However, the pair of extension holes **144** may in fact be replaced by a single extension hole, and the extension hole that aligns with the latch slot of the front door may in fact be higher on the adjusting rod **130** than the extension hole that aligns with the latch slot of the rear door.

The connection pin **142** serves to configure the adjusting rod **130** so that the vehicle door adjuster **10** may interact with the latch slot of the front door. As indicated, other structures may be used to configure the adjusting rod **130**.

V. Vehicle Door Adjuster with Raising Pedal

FIG. **7** is a side view of the exemplary vehicle door adjuster of FIG. **1** in accordance with the disclosed subject matter.

As shown in FIG. **7**, the vehicle door adjuster **10** includes the raising pedal **60** attached to the pedal post **50** by the post pin **52** inserted through the raising beam **62**. Specifically, the post pin **52** is inserted through the raising post slot **66** in the raising beam **62**. As shown in more detail in FIG. **14**, the raising post slot **66** has an oblong shape so that the raising beam **62** can slide horizontally back and forth around the post pin **52** as the raising beam **62** pivots up and down. This horizontal back and forth movement of the raising beam **62** around the post pin **52** is due to the fact that the raising beam **62** is rotatably attached to the adjusting rod **130** at the adjusting rod hole **68**. Actuation of the raising pedal **60** moves the adjusting rod **130** upward, thereby forcing the raising pedal platform **64** of the raising pedal **60** to slide closer to the pedal post **50**. As the raising pedal **60** slides closer to the pedal post **50**, the post pin **52** slides back towards the raising pedal platform **64** within the raising post slot **66** relative to the raising pedal **60**. This configuration resolves inconsistencies between the up and down movement of the adjusting rod **130** and the arcuate movement of the raising pedal **60**. The raising post slot **66** can also be shaped as a circular hole while the adjusting rod hole **68** is oblong shaped, or any other configuration made to accommodate for the differences in movement.

The raising post slot **66** serves to allow the raising pedal **60** and the adjusting rod **130** to be smoothly connected and operated. As indicated above, other configurations may be used to facilitate smooth movement of the raising pedal **60** and the adjusting rod **130**.

VI. Methods of Operation

As shown in the figures, the vehicle door adjuster **10** can be configured to adjust either a front or rear vehicle door. Before adjusting a vehicle door, the connection pin **142** is inserted into the correct extension hole **144** of adjusting rod **130**. In this case, the connection pin **142** must be inserted into the upper extension hole **144** of the adjusting rod **130**.

The vehicle door adjuster is moved to a position adjacent to the vehicle **190** at an open door such as the rear door **192**. At this point, the frame **40** may be pressed down toward the ground surface so that the grounding extensions **42** and **44**

contact the ground. This stabilizes the vehicle door adjuster **10** and will permit operation of the raising pedal **60** and the lowering pedal **80**.

Then, either the raising pedal **60** or the lowering pedal **80** is pressed to raise or lower the adjusting rod **130** and the attached connection pin **142**. In raising or lowering the connection pin **142**, the goal is to vertically align the connection pin **142** with the latch slot **194** of the rear door **192**. If the raising pedal **60** or the lowering pedal **80** has been pressed to the extent that the connection pin **142** has moved too far up or down past the latch slot **194**, the other pedal can be pressed to bring the connection pin **142** back into alignment.

Once the connection pin **142** is vertically aligned with the latch slot **194**, they are engaged. To engage, the connection pin **142** slides into the latch slot **194**, and a latch protrusion (not shown) engages with the connection pin **142**. This engagement locks the vehicle door adjuster **10** and the rear door **192** together.

After the vehicle door adjuster **10** and the rear door **192** have been engaged, either the raising pedal **60** or the lowering pedal **80** are pressed to move the rear door **192** up or down. Because the connection pin **142** connects the adjusting rod **130** and the rear door **192**, any movement of the adjusting rod **130** by the pedals will transfer to movement of the rear door **192**. Both the raising pedal **60** and the lowering pedal **80** may be used to intermittently raise and lower the rear door **192** until the correct position has been achieved.

At this point, the vehicle door adjuster **10** can be disengaged from the rear door **192** by pulling open the handle of the rear door **192** and releasing the latch protrusion. The vehicle door adjuster **10** may then be moved away from the vehicle **190** and out of the way.

The methods and apparatus disclosed above are beneficial for various reasons, for example, the adjuster utilizes structure similar to that found on the vehicle by including a connection pin that interacts with the door latch in a similar way as a vehicle striker bar. Because the vehicle door has a latch that is already configured to interact with the vehicle striker, no adjustments are necessary to facilitate the vehicle door interacting with the connection pin of the adjuster. Additionally, the adjuster incorporates improved ergonomics for technicians and other users for adjusting vehicle doors, particularly due to the mechanical advantage that the adjuster provides. Also, the adjuster facilitates more accurate adjustment of the vehicle door because the actuator can be more precisely operated than a direct force application on the vehicle door. Finally, the structure of the adjuster is such that the apparatus is easy to transport to various locations including those along an assembly line or amidst manufacturing operations.

VII. Alternative Embodiments of FIGS. **17-20**

FIGS. **17-20** show an alternative embodiment of the exemplary vehicle door adjuster **10** in accordance with the disclosed subject matter.

As shown in the alternate embodiment of FIG. **17-20**, the connection pin **142** is inserted through the extension hole **144** to lock together the adjusting rod **130** and either a front door extension **160** or a rear door extension **180**. The extension hole **144** of the adjusting rod **130** overlaps with corresponding holes in the front door extension **160** and the rear door extension **180** so that the connection pin **142** is likewise insertable. There can also be more than one extension hole **144** extending through the adjusting rod **130**, and the positioning of the extension hole or holes **144** may vary.

The extension hole **144** and the connection pin **142** serve to lock together the adjusting rod **130** and the front and rear door extensions **160** and **180**. As indicated above, other structures may be used to lock together the adjusting rod **130** and the front and rear door extensions **160** and **180**.

As shown in detail in FIGS. **17-20**, the front door extension **160** and the rear door extension **180** may each be removably attached to the top end of the adjusting rod **130**.

The front door extension **160** has a front striker **164** attached to a side of a top portion of a front rod **162**. The front rod **162** is cylindrical in shape, but can also be rectangular or otherwise polygonal in cross section. A base of the front rod **162** is configured to attach to the top end of the adjusting rod **130** by being threaded, tapered, or otherwise insertable. The front striker **164** can be attached to the front rod **162** by welding, use of adhesives or fixtures such as screws or bolts, etc. The front striker **164** includes a front striker plate **166** attached perpendicular to a front striker bar **168**, a back side of the front striker plate **166** being attached to the front rod **162**. The front striker bar **168** may also be attached to the front striker plate **166** by welding, use of adhesives or fixtures such as screws or bolts, etc. The front striker bar **168** defines an open space between itself and the front striker plate **166** through which the latch protrusion (not shown) of a vehicle door is inserted, as described below. The front striker bar **168** can be U-shaped, semicircular, or another shape defining an open space within a perimeter.

The rear door extension **180** has a rear striker **184** attached to a side of a top portion of a rear rod **182**. The rear rod **182** is cylindrical in shape, but can also be rectangular or otherwise polygonal in cross section. A base of the rear rod **182** is configured to attach to the top end of the adjusting rod **130** by being threaded, tapered, or otherwise insertable. The rear striker **184** can be attached to the rear rod **182** by welding, use of adhesives or fixtures such as screws or bolts, etc. The rear striker **184** includes a rear striker plate **186** attached perpendicular to a rear striker bar **188**, a back side of the rear striker plate **186** being attached to the rear rod **182**. The rear striker bar **188** may also be attached to the rear striker plate **186** by welding, use of adhesives or fixtures such as screws or bolts, etc. The rear striker bar **188** defines an open space between itself and the rear striker plate **186** through which the latch protrusion of the vehicle door is inserted, as described below. The rear striker bar **188** can be U-shaped, semicircular, or another shape defining an open space within a perimeter.

The front door extension **160** and the rear door extension **180** serve to extend the adjusting rod **130** to engage the vehicle door so that movement of the adjusting rod **130** moves the vehicle door up or down. As indicated above, other structures may be used to extend the adjusting rod **130** and engage the vehicle door.

FIG. **17** is a perspective view of an alternate embodiment of the vehicle door adjuster of FIG. **1** in use with the exemplary vehicle.

FIG. **17** particularly illustrates an alternate embodiment of the vehicle door adjuster **10**, made in accordance with the principles of the disclosed subject matter, in use with a vehicle **190**. As shown, the vehicle **190** has a rear door **192** that is in an open position. The rear door **192** includes a latch slot **194** configured to engage with a vehicle striker (not shown) when the rear door **192** is closed. When the rear door **192** is in the open position, the latch slot **194** is free to engage with the rear striker **184** of the vehicle door adjuster **10**, as described below.

In operation, the vehicle door adjuster **10** is moved along the surface on which it is supported to a position adjacent the rear door **192**. The vehicle door adjuster **10** can be moved manually or automatically, and can be rolled, slid, or carried.

Properly positioning the vehicle door adjuster **10** serves to allow alignment of the rear striker **184** with the latch slot **194**, and makes it easier to adjust the rear door **192**, and in particular requires less force for the adjustment. As indicated above, other structures may be used to align the rear striker **184** to the latch slot **194**, and facilitate adjustment of the rear door **192**.

Once properly positioned, the vehicle door adjuster **10** can be pressed toward the surface on which it is supported so that the grounding extensions **42** and **44** contact the surface. The pressing force must overcome the resistance of the caster springs **30** included in each caster assembly **20** in order for the vehicle door adjuster **10** to lower towards the surface. As the caster springs **30** are compressed, each caster assembly shaft **22** slides into corresponding vertical recesses of the frame **40**, thereby bringing the vehicle door adjuster **10** closer to the surface. The vehicle door adjuster **10** can be pressed toward the surface by manual or automatic force exerted downward on the frame **40**, grounding extensions **42** and **44**, or any other structural component. In an embodiment that does not include caster assemblies **20**, the vehicle door adjuster **10** is not pressed toward the surface and instead contacts the surface via feet or another static component.

Pressing the vehicle door adjuster **10** toward the surface on which it is supported serves to stabilize and support the vehicle door adjuster **10** while being operated. As indicated above, other structures may be used to stabilize and support the vehicle door adjuster **10**.

While the vehicle door adjuster **10** is pressed toward the surface, the raising pedal **60** and the lowering pedal **80** can then each be pressed (such as by the user's foot) separately to modulate an appropriate height of the adjusting rod **130** to the extent necessary to vertically align the rear striker **184** with the latch slot **194** of the rear door **192**. An initial height of the rear striker **184** determines whether the adjusting rod **130** needs to be moved up or down to align the rear striker **184** with the latch slot **194**, and consequently, whether the raising pedal **60** or the lowering pedal **80** is pressed. Alternatively, the adjusting rod **130** can be moved up or down directly without pressing on either the raising pedal **60** or the lowering pedal **80** because the vehicle door adjuster **10** is not yet attached to the rear door **192**.

Adjusting a height of the adjusting rod **130** serves to align the rear striker **184** with the latch slot **194** of the rear door **192** before the vehicle door adjuster **10** is engaged with the rear door **192**. As indicated above, other mechanisms may be used to vertically align the rear striker **184** with the latch slot **194**.

Once aligned at an appropriate height, the rear striker **184** and the latch slot **194** of the rear door **192** are engaged. The rear striker bar **188** of the rear striker **184** is inserted into the latch slot **194** and the latch protrusion engages with the open space defined between the rear striker bar **188** and the rear striker plate **186**. The rear striker **184** and the latch slot **194** are therein secured together such that movement of one corresponds to movement of the other.

Engaging the rear striker **184** of the adjusting rod **130** with the latch slot **194** of the rear door **192** serves to physically connect the vehicle door adjuster **10** to the rear door **192**, thereby allowing a transfer of force between the two. As indicated above, other structures may be used to engage the adjusting rod **130** with the rear door **192**.

Once the rear striker **184** and the rear door **192** are engaged, the raising pedal **60** and the lowering pedal **80** can then each be pressed (such as by the user's foot) separately to raise or lower the adjusting rod **130** to simultaneously raise or lower the rear door **192**. The rear door **192** is raised or lowered a distance corresponding to that which the adjusting rod **130** is raised or lowered by operation of the raising pedal **60** and the lowering pedal **80**.

After adjusting the rear door **192** to a desirable height, the rear striker **184** can be disengaged from the latch slot **194**. Pulling a door handle of the rear door **192** releases the latch protrusion from the open space between the rear striker bar **188** and the rear striker plate **186**, freeing the rear striker **184**.

The vehicle door adjuster **10** is then moved along the surface on which it is supported away from the rear door **192** of the vehicle **190**. With the vehicle door adjuster **10** out of the way and a height of the rear door **192** having been appropriately adjusted, the rear door **192** can be closed correctly.

FIG. **18** is a perspective view of an exemplary rear striker of the vehicle door adjuster of FIG. **17** engaged with the exemplary latch slot of the vehicle door.

As shown in FIG. **18**, the rear striker bar **188** of the rear striker **184** is vertically aligned with the latch slot **194** of the rear door **192**. The rear striker bar **188** extends into the latch slot **194** and engages with the latch protrusion (not shown) within an interior of the latch slot **194**. Top and bottom sides of the rear striker bar **188** abut against upper and lower portions of the latch slot **194** in the engaged state. When the rear striker bar **188** is moved up or down by virtue of the adjusting rod **130** being moved up or down, the rear striker bar **188** pushes up or down on the latch slot **194** and thereby moves the rear door **192**.

The rear striker bar **188** serves to engage the vehicle door adjuster **10** with the rear door **192** of the vehicle **190**, and enables subsequent adjustment of the rear door **192**. As indicated above, other structures may be used to engage and adjust the rear door **192**.

FIG. **19** is a perspective view of an exemplary front door extension in accordance with the disclosed subject matter.

As shown in FIG. **19**, the front door extension **160** of the present embodiment includes the front rod **162** attached to the front striker **164**. The front rod **162** has a length shorter than that of the rear rod **182**, which is described below. This difference in length is due to the fact that a latch slot of a front door is lower than the latch slot **194** of the rear door **192**, and the front striker **164** therefore does not need to extend as high above the adjusting rod **130**. However, the front rod **162** can also be equal in length to the rear rod **182**, or even longer.

Additionally, a bottom portion of the front rod **162** is tapered so that it may be inserted into a top portion of the adjusting rod **130**. The taper ensures the front rod **162** and the adjusting rod **130** will be firmly connected to one another. The front rod **162** may also be threaded at the bottom portion so that it can be screwed into the top portion of the adjusting rod **130**. Furthermore, as shown in more detail in FIG. **12**, a hole can be provided extending through a center of the front rod **162** that overlaps with an extension hole **144** extending through the adjusting rod **130** when the front rod **162** is inserted therein. An connection pin **142** is then inserted through both overlapping holes to lock together the front rod **162** and the adjusting rod **130**.

The front door extension **160** serves to raise the reach of the adjusting rod **130** by an length extension so that the vehicle door adjuster **10** may interact with the latch slot of

the front door. As indicated above, other structures may be used to extend the adjusting rod **130**.

FIG. **20** is a perspective view of the exemplary rear door extension of FIG. **17** in accordance with the disclosed subject matter.

As shown in FIG. **20**, the rear door extension **180** of the present embodiment includes the rear rod **182** attached to the rear striker **184**. The rear rod **182** has a length longer than that of the front rod **162**. This is because the latch slot **194** of the rear door **192** is higher than the latch slot of the front door, and the rear striker **184** therefore must extend higher above the adjusting rod **130**. However, the rear rod **182** can also be equal in length to the front rod **162**, or even shorter.

Additionally, a bottom portion of the rear rod **182** is tapered so that it may be inserted into a top portion of the adjusting rod **130**. The taper ensures that the rear rod **182** and the adjusting rod **130** will be firmly connected to one another. The rear rod **182** may also be threaded at the bottom portion so that it can be screwed into the top portion of the adjusting rod **130**. Furthermore, as shown in more detail in FIG. **12**, a hole can be provided extending through a center of the rear rod **182** that overlaps with the extension hole **144** extending through the adjusting rod **130** when the rear rod **182** is inserted. The connection pin **142** is then inserted through both overlapping holes to lock together the rear rod **182** and the adjusting rod **130**.

The rear door extension **180** serves to raise the reach of the adjusting rod **130** by a length extension so that the vehicle door adjuster **10** may interact with the latch slot **194** of the rear door **192**. As indicated above, other structures may be used to extend the adjusting rod **130**.

VIII. Alternative Embodiments

While certain embodiments of the invention are described above, and FIGS. **1-16** disclose the best mode for practicing the various inventive aspects, it should be understood that the invention can be embodied and configured in many different ways without departing from the spirit and scope of the invention.

In the disclosed embodiments, the invention is applied to vehicle doors. However, the invention could be applied or modified to adjust other components of vehicles such as body panels. In fact, the invention can even have applications outside of vehicles.

As disclosed above, embodiments are intended to be used with any type of vehicle. The power source of the vehicle can be an internal combustion engine, an electric motor, or a hybrid of an internal combustion engine and an electric motor. The power source configured as an internal combustion engine or a hybrid power source can have the engine output axis oriented in the longitudinal direction or in the traverse direction of the vehicle. The engine can be mounted forward of the front axles, rearward of the rear axles, or intermediate the front and rear axles.

In exemplary embodiments of the invention, the vehicle door adjuster includes pedals to be foot-operated. However, any mechanism can be used to conveniently raise and lower the vehicle door adjuster attachment that raises or lowers a vehicle door, such as hand-operated levers.

Additionally, the vehicle door adjuster includes a latch striker to engage a latch slot in the vehicle door, whereby force on the vehicle door adjuster pedals can be transferred to force on the vehicle door. However, the vehicle door adjuster can also be connected to the vehicle door by any structure other than the latch slot.

In embodiments disclosed in the context of FIGS. **1-16**, the vehicle door adjuster is configured to transfer force in a vertical direction to the vehicle door. However, the vehicle door adjuster may also be configured to transfer force horizontally, adjusting the vehicle door in a side to side manner. Further, the vehicle door adjuster may be oriented to transfer force in any direction, thereby adjusting the vehicle door in any direction.

Embodiments are also intended to include or otherwise cover methods of using and methods of manufacturing any or all of the elements disclosed above. The methods of manufacturing include or otherwise cover processors and computer programs implemented by processors used to design various elements of the vehicle door adjuster disclosed above.

While the subject matter has been described in detail with reference to exemplary embodiments thereof, it will be apparent to one skilled in the art that various changes can be made, and equivalents employed, without departing from the scope of the invention. All related art references discussed in the above Background section are hereby incorporated by reference in their entirety.

What is claimed is:

1. An adjuster supported by a static surface for adjusting a position of a vehicle door relative to other vehicle components of a vehicle, the vehicle including a striker that is configured to communicate with and be held by a latch of the door to enable the door to be held in a fully closed position, the vehicle also including a release mechanism that enables the striker to be released from the latch to thereby enable the door to be released from the fully closed position and maneuvered into an open position, the adjuster comprising:

a pin that is configured to be held by the vehicle door latch so as to form a rigid connection between the pin and the vehicle door, the pin also being configured to be released from the vehicle door latch upon actuation of the vehicle release mechanism;

a frame configured to be supported by the static surface; and

a manual actuator assembly having a pedal that connects the frame to the pin, and that is configured to displace the pin by a predetermined distance upon depressing the pedal to thereby move the vehicle door to a position in which the vehicle door latch and the vehicle striker are aligned;

wherein the manual actuator assembly includes a rod that connects the pin to the frame, and the pedal is configured as a raising pedal connected to one end of a raising beam, and a pivot bar is connected to the frame and to an intermediate portion of the raising beam to enable pivoting movement of the raising pedal and the raising beam relative to the frame, an opposite end of the raising beam being rotatably connected to a lower portion of the rod such that manually actuating the raising pedal downwardly moves the rod in an upward direction.

2. The adjuster according to claim **1**, wherein the pin is configured to be held by the vehicle door latch in substantially the same way as the vehicle striker.

3. The adjuster according to claim **2**, wherein the pin is substantially cylindrical and extends perpendicular to a direction of movement of the vehicle door.

4. The adjuster according to claim **1**, wherein the frame includes a main frame and wheels connected to a lower surface of the main frame that enable the adjuster to be manually moved between different locations.

5. The adjuster according to claim 4, wherein the frame includes grounding extensions attached to the lower surface of the main frame, and telescoping shafts that connect the wheels to the lower surface of the main frame.

6. The adjuster according to claim 5, wherein the telescoping shafts are movable between a fully extended position and a fully retracted position, the fully extended position resulting in the combined height of the wheels and the telescoping shafts as being greater than a height of the grounding extensions, while the fully retracted position resulting in the combined height of the wheels and the telescoping shafts as being less than the height of the grounding extensions, the telescoping shafts being movable between the fully retracted and fully extended positions based on an amount of downward force applied to the main frame.

7. The adjuster according to claim 1, wherein the frame includes an adjusting rod guide extension that extends from an upper surface of the frame and within a hollow portion of the rod so as to guide vertical movement of the rod.

8. The adjuster according to claim 7, wherein the manual actuator assembly includes a guide block and braces, the guide block defining a channel through which the rod extends, and the braces rigidly connecting the guide block to the frame.

9. The adjuster according to claim 1, wherein the manual actuator assembly includes a lowering pedal connected to one end of a lowering beam, the pivot bar being connected to a mid-point of the lowering beam to enable pivoting movement of the lowering pedal and the lowering beam relative to the frame, the lowering beam also including a cable having one end that is connected to the lowering beam at a location between the mid-point and the one end of the lowering beam, an opposite end of the cable being connected to the lowering beam at a location between the mid-point and an end opposite the one end of the lowering beam, the lowering beam also including a hook attached to an upper section of the rod, the hook defining a channel through which the cable extends, such that manually actuating the lowering pedal downwardly moves the rod in a downward direction.

10. A method of manufacturing an adjuster supported by a static surface for adjusting a position of a vehicle door relative to other vehicle components of a vehicle, the vehicle including a striker that is configured to communicate with and be held by a latch of the door to enable the door to be held in a fully closed position, the vehicle also including a release mechanism that enables the striker to be released from the latch to thereby enable the door to be released from the fully closed position and maneuvered into an open position, the method of manufacturing comprising:

configuring a pin to be held by the vehicle door latch so as to form a rigid connection between the pin and the vehicle door, the pin also being configured to be released from the vehicle door latch upon actuation of the vehicle release mechanism;

connecting the pin to a frame supported by the static surface with a manual actuator assembly having a pedal and a rod;

configuring the manual actuator assembly to displace the pin by a predetermined distance upon depressing the pedal to thereby move the vehicle door to a position in which the vehicle door latch and the vehicle striker are aligned; and

configuring the pedal as a raising pedal connected to one end of a raising beam, wherein a pivot bar is connected to the frame and to an intermediate portion of the raising beam to enable pivoting movement of the raising pedal and the raising beam relative to the frame, an opposite end of the raising beam being rotatably connected to a lower portion of the rod such that manually actuating the raising pedal downwardly moves the rod in an upward direction.

11. The method of manufacturing according to claim 10, further including configuring the pin to be held by the vehicle door latch in substantially the same way as the vehicle striker.

12. The method of manufacturing according to claim 11, further including configuring the pin to be substantially cylindrical and to extend perpendicular to a direction of movement of the vehicle door.

13. The method of manufacturing according to claim 10, further including configuring the frame to include a main frame and wheels connected to a lower surface of the main frame that enable the adjuster to be manually moved between different locations.

14. The method of manufacturing according to claim 13, further including configuring the frame to include grounding extensions attached to the lower surface of the main frame, and telescoping shafts that connect the wheels to the lower surface of the main frame.

15. The method of manufacturing according to claim 14, further including configuring the telescoping shafts to be movable between a fully extended position and a fully retracted position, the fully extended position resulting in the combined height of the wheels and the telescoping shafts as being greater than a height of the grounding extensions, while the fully retracted position resulting in the combined height of the wheels and the telescoping shafts as being less than the height of the grounding extensions, the telescoping shafts being movable between the fully retracted and fully extended positions based on an amount of downward force applied to the main frame.

16. The method of manufacturing according to claim 10, further including wherein the frame includes an adjusting rod guide extension that extends from an upper surface of the frame and within a hollow portion of the rod so as to guide vertical movement of the rod.

17. The method of manufacturing according to claim 16, further including configuring the manual actuator assembly to include a guide block and braces, the guide block defining a channel through which the rod extends, and the braces rigidly connecting the guide block to the frame.

18. A method of adjusting a position of a vehicle door relative to other vehicle components of a vehicle supported by a static surface, the vehicle including a striker that is configured to communicate with and be held by a latch of the door to enable the door to be held in a fully closed position, the vehicle also including a release mechanism that enables the striker to be released from the latch to thereby enable the door to be released from the fully closed position and maneuvered into an open position, the method comprising:

opening the vehicle door;

configuring an adjuster to include an actuator pedal, a pivot bar, a raising beam, a frame, a rod, and a pin, the actuator pedal is connected to one end of the raising beam, the pivot bar is connected to the frame and to an intermediate portion of the raising beam to enable pivoting movement of the actuator pedal and the raising beam relative to the frame, an opposite end of the raising beam being rotatably connected to a lower portion of the rod such that manually actuating the raising pedal downwardly moves the rod in an upward direction;

moving the adjuster to be proximate the open vehicle door and so as to be supported on the static surface;

maneuvering the pin of the adjuster so as to be held by the vehicle door latch so as to form a rigid connection between the pin and the vehicle door;

manually operating the actuator pedal of the adjuster to displace the pin by a predetermined distance to thereby move the vehicle door to a position in which the vehicle door latch and the vehicle striker are aligned; and

actuating the vehicle release mechanism so that the pin is released from the vehicle door latch.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,994,271 B2
APPLICATION NO. : 14/804329
DATED : June 12, 2018
INVENTOR(S) : Eric Vanderpool et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Item [72], should read:
Eric Vanderpool, Batesville, IN (US);
Bryan MERMOUD, Shelbyville, IN (US);
William Tyler SELF, Butlerville, IN (US);
Micah REDWINE, Shelbyville, IN (US)

Signed and Sealed this
Twenty-first Day of August, 2018

Andrei Iancu
Director of the United States Patent and Trademark Office